



ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ

**Visvesvaraya Technological University**

"Jnana Sangama", Belagavi - 590 018, Karnataka State.

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**REGISTRAR**

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VTU/Aca/BGM/Ph.D./2019-20/ 278

Date: 21 DEC 2019

### Revised Circular

Sub: Syllabus for VTU-ETR Ph.D./M.Sc. (Engineering) by Research 2019-20.

In order to demonstrate programme wise knowledge in the disciplines related to the candidate's own research field, the question paper pattern for the Visvesvaraya Technological University – Eligibility Test for Research (VTU-ETR) has been revised and the same is applicable with effect from the year 2019 – 20.

The VTU – ETR is conducted for 100 marks and the VTU – ETR paper pattern is as shown in the table below:

Table showing the details of VTU – ETR paper pattern			
Particulars of the syllabus		Questions set and Marks prescribed	
Part - I	Research Methodology (Compulsory) (Candidates have to answer the Programme/discipline based Part - I paper to which they have registered)	50 Questions	50 MARKS
Part - II	Programme based syllabus (Compulsory) (Candidates have to answer the Programme/discipline based Part - II paper to which they have registered)	50 Questions	50 MARKS

The Circular No VTU/BGM/Ph.D./2019-20/189 dated: 11/11/2019 immediately stands cancelled Therefore, here onwards this revised Circular order will be in effect and implemented for the above mentioned ETR Syllabus

The contents of this circular may be brought to the notice of all the concerned. The detailed syllabuses for all the parts, programme/discipline wise, are available on the following link [www.vtu.ac.in](http://www.vtu.ac.in)

  
REGISTRAR

**Copy to:**

1. The Hon'ble Vice Chancellor, through the Secretary to VC, VTU, Belagavi
2. The Registrar office, VTU, Belagavi for information.
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4. The Director (I/c), ITISMU VTU, Belagavi for information and uploading on website.
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**Visvesvaraya Technological University**

“Jnana Sangama”, Belagavi - 590 018, Karnataka State.

**Ph.D/M.Sc(Engg)**

**Entrance Test Syllabus**

**For the year 2019-20**

**Part – A of VTU - ETR: RESEARCH METHODOLOGY**  
**(Common to Engineering Programmes, MCA, MBA and Basic Sciences) (Weightage 50%)**

**UNIT - 1**

**Research Methodology:** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

**UNIT - 2**

**Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

**UNIT - 3**

**Design of Sample Surveys:** Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

**UNIT – 4**

**Data Preparation:**Data Preparation Process, Some Problems in Preparation Process, Missing Values and Outliers, Types of Analysis, Statistics in Research. Descriptive Statistics: Measures of Central Tendency, Measures of Dispersion, Measures of Skewness, Kurtosis, Measures of Relationship, Association in case of Attributes, Other Measures.

**UNIT - 5**

**Sampling and Statistical Inference:** Parameters and Statistic, Sampling and Non- Sampling Errors, Sampling Distribution, Degree of Freedom, Standard Error, Central Limit Theorem, Finite Population Correction, Statistical Inference.

**UNIT - 6**

**Testing of Hypotheses:** Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Caution in Using Chi Square Tests.

**UNIT – 7**

**Analysis of Variance (ANOVA):** The ANOVA Technique, Basic Principle of ANOVA, One way ANOVA, Two way ANOVA, Latin – square Design, Analysis of Co- Variance, Assumptions in Co- Variance. UNIT – 8 Linear Regression Analysis: Dependent and Independent Variables, Simple Linear Regression Model, Multiple Linear Regression Model, Problem of Multicollinearity, Qualitative Explanatory Variables. Factor Analysis: The Mathematical Basis, Important Methods of Factor Analysis, Rotation in Factor Analysis, R – Type and Q – Type Factor Analysis, Merits and Demerits of Factor Analysis.

## **UNIT – 9**

**Probability:** Random Experiments, Sample Spaces, Events, The Concept of Probability, The Axioms of Probability, Theorems on Probability, Assignment of Probabilities, Conditional Probability, Theorems on Conditional Probability, Independent Events, Bayes' Theorem. Random Variables, Discrete Probability Distributions, Distribution Functions for Random Variables, Distribution Functions for Discrete Random Variables, Continuous Random Variables, Graphical Interpretations, Joint Distributions Independent Random Variables, Change of Variables, Probability Distributions of Functions of Random Variables, Convolutions, Conditional Distributions.

## **UNIT - 10**

The Binomial Distribution, Properties of the Binomial Distribution, The Normal Distribution, Properties of the Normal Distribution, Relation Between Binomial and Normal Distributions, The Poisson Distribution, Properties of the Poisson Distribution, Relation Between the Binomial and Poisson Distributions, Relation Between the Poisson and Normal Distributions, The Hypergeometric Distribution.

### **Reference Books:**

- (1) Research Methodology Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International Publishers, 4th Edition, 2019.
- (2) Research Methodology a step-by-step guide for beginners, Ranjit Kumar, SAGE Publications Ltd, 3rd Edition, 2011. [For Unit -2, Reviewing the Literature]
- (3) Probability and Statistics, Murray R. Spiegel, Schaum's Outline Series, McGraw-Hill, 4th Edition, 2013. [For Unit -9 and Unit – 10]

**PART – A of VTU – ETR in Architecture**  
**RESEARCH METHODOLOGY IN ARCHITECTURE (Weightage 50%)**

**UNIT - 1**

**Introduction to Research:** Science and Scientific Research, Scientific Knowledge, Scientific Method, Types of Scientific Research, Concepts, Constructs, and Variables, Propositions and Hypotheses.

**UNIT - 2**

**Social Research:** Paradigms of Social Research, Types of Social Research, Social Research Methods, ethnography, Cross-sectional, Longitudinal, Cross-sequential.

**UNIT - 3**

**Architectural Research:** Introduction to design and Research, Facets of Difference, Facets of Similarity, The Scope of Design and Research. Frameworks for Understanding measures of Research Quality, Validity, Objectivity, Reliability. Literature Review and Research Design: Bibliography, References, types of sources, Research Questions, Methodology in Relation to the Literature.

**UNIT - 4**

**Examples of Architectural Research:** Single case, multiple case, comparative case study research etc.

**UNIT - 5**

**Research Methodology/Process:** Overview of the Research Process, literature review, research design, Operationalization, research method, sampling, Pilot testing, data collection, data analysis, research report. **UNIT - 6 Tools and Techniques of Architectural Research:** Research Strategies: Historical Research; Qualitative Research: Correlational Research: Experimental and Quasi-Experimental Research: Simulation Research.

**UNIT - 7**

**Research Surveys:** Types of surveys, methodology of survey research. Definitions of reliability, theory of reliability. Types of validity. Variance definitions of validity. Interview schedule, examples of interview as a research tool. Sampling, random sampling and representativeness. Randomization, sample size and kinds of samples, Levels of Measurement.

**UNIT - 8**

**Hypothesis:** Introduction, criteria of a good hypothesis, directional and nondirectional Hypothesis, Statistical Hypothesis, Hypothesis testing.

**UNIT – 9**

**Introduction to Statistics:** Elements of Structured Data, Data Types (Continuous, Discrete, Categorical, Binary and ordinal). Mean, differences, correlation coefficients. Correlation coefficients. The law of average numbers, binomial statistics and variance. Standard deviation. Correlation, Variance, Co Variance, Uni-variate, Bi-variate and multivariate analysis of data. Data Frames and Indexes, interpretation of data using normal probability curve.

**UNIT - 10**

**Research Writing:** Introduction to technical writing, content of research paper, bibliography, references, Referencing styles, research ethics, Intellectual Property Rights (IPR), Plagiarism.

**Reference Books:**

- (1) Social Science Research: Principles, Methods, and Practices, Bhattacharjee, Anol, Textbooks Collection. Book .[http://scholarcommons.usf.edu/oa\\_textbooks/3](http://scholarcommons.usf.edu/oa_textbooks/3), (2012).
- (2) Research Methodology- A step by step guide for Beginners, Ranjit Kumar, Sage Publications, New Delhi.
- (3) Foundations of Behavioural Research, Fred N. Kerlinger, Holt, Rinehart and Winston Inc, New York.
- (4) Architectural Research Methods, Kerry London and Michael Ostwald, John Wiley and Sons, New York: 2002
- (5) Fundamentals of Statistics, S. C. Gupta, Himalaya Publishing House, 2018

**Part – II Syllabus for Ph.D. Entrance Examination**  
**Aeronautical/Aerospace Engineering (Weightage 50%) (Subject Specific)**

**Unit - 1.**

**Fluid Mechanics:** Physical properties of fluids, Fluid Statics, Fluids in motion, Fluid Kinematics, Fluid Dynamics, Dimensional analysis and similarity, Flow past Immersed bodies, Compressible flow and Boundary Layers theory.

**Unit - 2.**

**Aerodynamics:** Airfoil characteristics, two dimensional flows & incompressible flow over airfoil, incompressible flow over airfoils, applications of finite wing theory & high lift systems, Prandtl's classical lifting line theory. Compressible Flow, Normal Shock, Oblique shocks and Expansion waves, Differential Equations of Motion for Steady Compressible Flows, Measurements in High speed Flow.

**Unit - 3.**

**Mechanics of Material:** Basics of linear elasticity, simple and compound stresses, bending moment and shear force in beams, Euler-Bernoulli beam theory, deflection of beam, Torsion of circular shafts and elastic stability of columns, Virtual work principles, Energy methods, Mechanical Properties of materials.

**Unit - 4.**

**Aero structures:** Design for Static Strength, Design for Impact and Fatigue Strength, Loads on Aircraft and Aircraft Materials, Theory of Elasticity and Structures, Energy Methods and Columns. Bending of Open and Closed Thin Walled Beams, Shear and Torsion of Open and Closed Thin Walled Beams, Buckling of Plates, Joints and Fittings, Design Criteria and Structural Idealization, Stress Analysis in Wing Spars and Box beams

**Unit - 5.**

**Aerothermodynamics:** Fundamental concepts and definitions, work and heat, first law of thermodynamics, second law of thermodynamics, entropy, pure substances and ideal gases, thermodynamic relations, gas power cycles, vapour power cycles.

**Unit - 6.**

**Aircraft Propulsion:** Introduction, Propeller Theories & Jet propulsion, Inlets & Nozzles, Supersonic inlets, Nozzles, Gas Turbine Engine Compressors, Centrifugal compressors, Axial flow compressors, Combustion chambers and Turbines, Axial Flow Turbines, Radial turbine.

**Unit - 7.**

**Aircraft Materials and Processes:** Introduction to Aircraft Materials, Aircraft Metal Alloys, Super Alloys, Composite Materials, Polymers, Polymeric Materials & Plastics and Ceramics & Glass, Ablative Materials, Aircraft Wood, Rubber, Fabrics & Dope and Paint, fatigue and creep, Corrosion and its Prevention, High Energy Materials.

**Unit - 8.**

**Aircraft Performance:** The Equations of Motion Steady Unaccelerated Flight, Steady Performance – Level Flight, Climb & Glide, Fundamental Airplane Performance Parameters, Range and Endurance, Aircraft Performance in Accelerated Flight, Manoeuvre Performance.

**Unit - 9.**

**Space Mechanics:** Types of orbits, Introduction to rocket propulsion-fundamentals of solid propellant rockets, liquid propellant rockets and hybrid rockets, Rocket equation, Specific Impulse, Multi-stage rockets, Single Stage to Orbit, attitude of rocket, Gravity Turn Trajectories, Impact point calculation, injection conditions-Flight dispersions, Burnout velocity.

**Unit - 10.**

**Aircraft Systems and Instrumentation:** Power Distribution System, Navigation System, Electronic Flight Control System, Electronic Flight Instrument Systems, Introduction to Avionics Sub Systems and Electronic Circuits, Principles of Digital Systems, Flight Deck and Cockpits, Avionics Systems Integration. Engine Systems, Auxiliary Systems.

## Automobile Engineering (Weightage 50%) (Subject Specific)

### UNIT 1

**Engineering Mechanics:** Concept of stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment; stresses in beams; torsion of circular shafts;

**Theory of Machines:** Displacement, velocity and acceleration of plane mechanisms; cams; gears and gear trains;

#### Reference Books

- 1 Strength of Materials James M Gere, Barry J .Goodno, Cengage Learning, 2009
- 2 Strength of Materials S. S. Bhavikatti , Vikas publications House, -1 Pvt. Ltd, 2006
- 3 Theory of Machines Rattan S. S. ,Tata McGraw-Hill Publishing, Company Ltd., New Delhi,3rd edition -2009

### UNIT 2

**Mechanical Vibrations:** Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

**Machine Design:** Static and dynamic force analysis; Balancing of rotating and reciprocating masses, flywheel and governor, gyroscope, failure theories; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, brakes and clutches bearings and springs.

#### Reference Books

- 1 Mechanical Vibrations,G. K. Grover and S.P. Nigam Nemchand and Brothers, Roorkee,2009
- 2 Fundamentals of Mechanical Vibrations, S. Graham Kelly, McGraw Hill Publishing Co. Ltd., 2000
- 3 Mechanical Engineering Design, Joseph E shigley and Charles R. G. Budynas, McGraw hill International edition- 6 , 2009
- 4 Theory and problems of Machine Design (Schaum's Outlines series), Hall, Holowenko, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2014

### UNIT 3

**Fluid Mechanics:** Properties of fluids, manometry principle, buoyancy and floatation, stability of floating bodies; fluid kinematics,

**Fluid dynamics-** Euler's & Bernoulli's equation; concept of dimensional analysis; Fluid flow measurements, viscous flow (incompressible fluids), concepts of boundary layer, flow through pipes.

#### Reference Books

- 1 Fluid Mechanics (SI Units) ,Yunus A. Cengel John M.Cimbala, TMH , 2006
- 2 Fluid Mechanics, Bansal, R. K., Lakshmi Publications, 2004

### UNIT 4

**Basic and Applied Thermodynamics:** Thermodynamic systems and processes; laws of thermodynamics, concept of work and heat, entropy , pure substances , Air compressors, Vapour compression and vapour absorption cycles, basic concepts of psychrometry and psychrometric processes, concept of cooling load calculations.

**Heat-Transfer:** Modes of heat transfer; one dimensional heat conduction in slabs and cylinders(without heat generation), resistance concept and electrical analogy, fins, transient heat conduction, basics of free and forced convective heat transfer, heat exchangers-performance and LMTD and NTU concepts; Radiation, laws of radiation

#### Reference Books

- 1 Thermodynamics, An engineering approach, Yunus, A. Cengel and Michael A.Boies, Tata Mac- Graw Hill Publishing Company, 2002
- 2 Engineering Thermodynamics, P. K. Nag, Tata McGraw Hill, 2002
- 3 Heat transfer-A basic approach Ozisik, Tata McGraw Hill. 2002
- 4 Heat & Mass transfer, Tirumaleshwar, Pearson education, 2006

## UNIT 5

**Engineering Materials:** Crystal structure and properties of engineering materials phase diagrams, heat treatment, Ferrous and Non ferrous materials, composite materials-Types, FRP, MMC

**Casting, Forming and Joining Processes:** Different types of castings, Concept of patterns, moulds and cores, special moulding processes and furnaces, Joining processes viz., welding, brazing, soldering.

### Reference Books

- 1 Foundations of Materials Science and Engineering, Smith, McGraw Hill, 2009, 3rd Edition
- 2 Materials Science, Shackelford & M. K. Muralidhara, Pearson Publication, 2007

## UNIT 6

**Machining and Machine Tool Operations:** Theory of metal cutting & cutting tool materials, machining, basic machine tools, tool geometry, tool life and wear, principles of non-traditional machining processes

**Measurement, measurement systems and standards of measurements:** Fundamental concepts of limits, fits and tolerances; PERT and CPM Techniques, Basic concepts of CAD/CAM and their integration tools, NC, CNC machine tools, Introduction to robotics.

### Reference Books

- 1 Manufacturing Science, Amitabh Ghosh and Mallik. Affiliated East West Press, 2003
- 2 Engineering Metrology, R. K. Jain ,Khanna Publishers, New Delhi,2007
- 3 Operations Research , S. D. Sharma, Ledarnath Ramanath & Co. , 2002
- 4 CAD/CAM Principles and Application, P. N. Rao, Tata McGraw Hill, 2010

## UNIT 7

**IC Engine basics:** Energy sources, Liquid fuels, I C Engine fuels, Air-standard Otto, Diesel cycles Combustion in SI and CI engines, Engine performance, Dual fuel and multi-fuel engines

**Engine emission and Pollution control:** Pollution formation mechanism, pollutants, pollution control techniques, Post combustion treatments, Instrumentation for pollution measurements

### Reference Books

- 1 Internal combustion engines, V. Ganesan ,Tata McGraw Hill Book Company,1995
- 2 Internal combustion engine fundamentals, John B. Heywood, McGraw Hill Book, publication, 1998

## UNIT 8

**Automotive electrical and electronic systems:** Storage battery, starter and motor drives, ignition and lighting systems

**Advanced Engine Technology:** Engine management systems, Energy storage technology,

### Reference Books

- 1 Automobile Electrical and Electronic systems, Tom Denton, SAE publication, 2000
2. Advanced Engine Technology , Heinz Heisler, SAE Publications, 1995

## UNIT 9

**Automation, Production system:** CIM systems automated flow line &Line balancing, automated assembly and guided vehicle systems,

**Vehicle body engineering and Safety:** Vehicle body materials, aerodynamics, load distribution, Noise and vibration, Safety and stability.

### Reference Books:

1. Automation, Production system & Computer Integrated- M.P. Grover,Pearson India, 2007
- 2 Vehicle body engineering Giles J Pawlowsky, Business books limited,1989
- 3 Vehicle Safety, Cornwell press Town bridge, UK, 2002 , ISBN:1356 - 1448

## **UNIT 10**

**Supercharger, Working Principle, Effect of Super charging, Types and Methods of Super charging, Turbo Charger, Working Principle, Turbo-lag**

**Recent Developments in Automotive Engines:** VVT, V-TEC i-VTEC and IDTEC. ATFT, CRDI system- working Principle, Electrical and Hybrid vehicles and fuel cells

### **Reference Books:**

1. Electric and Hybrid Vehicles Robin Hardy, Iqbal Husain, CRC Press, ISBN :0-8493-466-6
2. Internal combustion engine fundamentals, John B. Heywood, McGraw Hill Book, publication, 1998
3. Propulsion Systems for Hybrid Vehicles- John M. Miller, Institute of Electrical Engineers, London.

## **Biotechnology Engineering (Weightage 50%) (Subject Specific)**

### **UNIT 1**

**BASICS OF UNIT OPERATIONS** :Basics of Sedimentation, Setting, Filtration, Size Reduction and mixing ; Basic modes of heat transfer, Uni Layer, Multi-Layer and steady state conduction. Principles of Diffusion, Distillation, Drying, Evaporation, Extraction, Adsorption and Ion-exchange operations

### **UNIT 2**

**FUNDAMENTALS OF MOMENTUM TRANSFER**:Fluid definition, Classification, governing equations, Hydrostatic equilibrium, barometric equation, Pressure measurements, Manometric equation, Shear stress, Shear strain, Newton's law, Fluid Flow. Types of Flow, laminar and Turbulent. Flow Continuity equation, Energy balance equation. Bernoulli's equation, Euler equation, Momentum balance, Flow through circular and non circular Sections, Hagen-Poiseuille equations, Losses through pipe and fittings, Turbulent flow, and Friction factor

### **UNIT 3**

**BASIC BIOCHEMISTRY**:Structure and properties of mono, di, and polysaccharides, structure and properties of fatty acids, neutral fats, phospholipids, glycolipids and steroids, structure and properties of amino acids, Peptides, and proteins, Biologically important peptides, Structure and properties of purines, pyrimidines, nucleosides, nucleotides, ribonucleic acids, nucleoprotein complexes.

### **UNIT 4**

**FUNDAMENTALS OF CELL STRUCTURE AND FUNCTION**:Eukaryotic and prokaryotic cells, Plant and animal cells, Types of cell functions, cell division, Mitosis and Meiosis formal structure in cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes Endoplasmic Reticulum Peroxisomes Chloroplast and Vacuoles. Cell to cell Integration Cell Locomotion (Amoeboid, Flagella, Cillar); Muscle and Nerve cell; Structure and functioning of endocrine cells including neuro secretory cell. Cell culture Techniques: Animal, plant and Microbial cell culture techniques.

### **UNIT 5**

**BASICS OF BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES**:Rayleigh scattering, ultra centrifugation, viscometry, crystallization, X-ray crystallography, neutron diffraction, NMR Spectroscopy, electron microscopy, STM, AFM luminescence, fluorimeter, flame photometry, optical activity, CD, UV, IR, Laser Raman and ESR EPR. Calorimetry, DSC, Spectrophotometry; Mass spectrometry, LC-MS, MALDI-TOF, Chromatography, Electrophoresis.

### **UNIT 6**

**FUNDAMENTALS OF THERMODYNAMICS**:System Surrounding and Process, Closed and open system, State and Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state and Phase rule, Zeroth law of Thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes. General Statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process

### **UNIT 7**

**BASIC GENETICS AND GENETIC ENGINEERING**:Nature of genetic material, DNA replication, Mendelian Laws of Inheritance, monohybrid and, dihybrid Inheritance, law of segregation and Independent assortment, Gene Interactions, Supplementary genes, Complementary, genes, Epistasis. Identification of genetic material Classical experiments- Hershey & Chase, Avery McLeod etc. Multiple alleles and group antigens; Role of genes within cell, genetic code, genetic elements that control gene expression, method of creating recombinant DNA molecules vectors in recombinant DNA technology, biology and salient features of vectors, types of vectors plasmids cosmids phages and viruses. Gene

transfer techniques, genetic engineering of plants and animals, structure and functions of T-DNA in the expression of genes, Ti plasmid mediated gene transfer

#### **UNIT 8**

**INTRODUCTORY BIOINFORMATICS:**Databases Sequence database, Structure database, Medical Databases, Sequence alignment and database searches: optional Alignment, Database similarity searching, FASTA, BLAST. Aspects of multiple sequence alignment; Phylogenetic analysis; Tree-Building Methods, Evaluating Trees and data; Predictive methods for detecting functional sites in the DNA, Predictive methods for secondary structure, tertiary folds from protein sequences. Plasmid mapping and primer design.

#### **UNIT 9**

**BIOPROCESS PRINCIPLES:**Concept or mole and Molecule; Composition, of mixtures of Solids, liquids and gases; Composition of mixtures and solutions Percentage by weight, mole and Volume; Normality, Molarity, Molality and ppm; pH and pK Buffer Calculations; Outline of an Integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocess; generalized process flow sheets, Process flow sheet and unit operations in chemical and bioprocess Industries; General material balance equation for steady and unsteady states. Basic concepts of Energy balance. Couples reactions and energy rise compounds, Reaction stoichiometry, criteria of Biochemical reaction equilibrium, Equilibrium constant and standard free energy, effect of temperature, pressure on equilibrium constants and other factors affecting equilibrium conversion, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems

#### **UNIT 10**

**BASICS OF MICROBIOLOGY AND IMMUNOLOGY:**Differential Staining Techniques, Sterilization & disinfection, Growth curve patterns, Physical conditions required for growth. Metabolism; Primary and Secondary metabolites with examples. Atmospheric Microbiology: Aerobiology and allergy. Air sampling principles and types of samplers. B-lymphocytes and their activation, Class switching mechanism, antibody genes and generation of diversity, production of monoclonal antibodies, polyclonal antibodies and applications, cytokines, Thymus derived lymphocytes (T cells) - their ontogeny and types, Activation of T-cells. Antigen antibody interaction, Agglutination reactions. Immune response to infections: immunity to viruses, bacteria, fungi and parasites, Immunodeficiency disorders

## **Biomedical Engineering / Medical Electronics (Weightage 50%) (Subject Specific)**

### **Unit 1**

**Basic Electronics and Network Analysis:** Semiconductor diodes and applications, BJT, BJT biasing, DC load line and bias point, base bias, Voltage divider bias.

Basic concepts network analysis, Nodal analysis, Mesh analysis, Network theorems, Transient behavior and Initial conditions, Two port network parameters, Resonant circuits, Network topology.

### **Unit 2**

**Analog Electronics and Signal Conditioning Circuits:** BJT AC analysis, FET, MOSFET, FET biasing, FET amplifiers, BJT and FET frequency response, Feedback and Oscillator circuits.

Op-amp characteristics and applications, Integrator, differentiator, Wave shaping circuits, F to V and V to F converters, Active filters, Schmitt trigger, Phase locked loop, 555 timers, Analog to Digital converters and Digital to Analog converters.

### **Unit 3**

**Digital Design and HDL:** Switching and Logic Levels, Number systems, Number conversion, Boolean algebra and minimization techniques, Combinational circuits, Sequential circuits, Counters and shift registers, Analysis and design of digital circuits using HDL (Verilog).

### **Unit 4**

**Microcontrollers:** Introduction to Microcontrollers-8051 for embedded systems, Architecture and register set of 8051, Addressing modes, Instruction set of 8051-Data transfer instructions, Arithmetic instructions, logical instructions, bit and byte level control transfer instructions, 8051 assembly programming-stack operations, subroutines, interrupt, 8051 programming as timer/counter, 8051 serial communication 8051 interfacing RS-232, LED, Stepper motor.

### **Unit 5**

**Measurement Systems and Biomedical Transducers:** Measurement system, Measurement errors, Ammeter, voltmeter, multimeter, Digital voltmeter, Digital instruments, Oscilloscope, Digital oscilloscopes, Signal generators, Bridge circuits for measurement of R, L, and C. Display devices and recorders, Frequency measurements and phase measurements.

Fundamental concepts and basics of transducers, Bioelectric Signals and Electrodes, Pressure Measurement, Temperature transducers, Photoelectric transducers, Flow Transducers,

### **Unit 6**

**Human Anatomy and Physiology:** Introduction to Homeostasis, Tissue, Cartilage, Nervous System, Cardiovascular System, Respiratory system, Digestive system, Urinary system, Skeletal system, Muscles and Joints, Eye and Ear.

### **Unit 7**

**Control Systems and Communication Systems:** Basics of control systems, Block diagram Reduction, Signal flow graph, Time response analysis, Concepts of stability, Nyquist criteria, Root locus technique, and Bode plot.

Amplitude modulation, Angle modulation, Pulse modulation, Digital Band-Pass Modulation Techniques.

### **Unit 8**

**Fundamentals of Signals, DSP and Biomedical DSP:** Introduction to signal and systems, Z-transform and its application to analysis of LTI systems, realization of Digital systems, DFT: Properties and Applications, IIR and FIR filters.

Nature of biomedical signals and basics of biomedical DSP, Filtering for Artifacts Removal, Signal averaging, ECG signal processing, Data compression techniques.

### **Unit 9**

**Medical Image Processing and Medical Imaging Techniques:** Fundamentals of digital image processing, Image Enhancement in Spatial Domain, Image Enhancement In Frequency Domain, Image Restoration, Image compression, Image segmentation.

X-Ray Imaging, Computed Tomography, Ultrasound Imaging, Ultrasonic Diagnostic Methods, Radionuclide Imaging, Basics of Magnetic Resonance Imaging, MRI System & Imaging Methods.

### **Unit 10**

**Analytical Instrumentation and Biomedical Instrumentation:**

Basics of analytical instrumentation, IR Spectroscopy, UV and Visible Spectroscopy, Flame emission and Atomic Absorption spectroscopy, Gas chromatography, HPLC.

Electrocardiograph, Electroencephalograph, Electromyograph, Cardiac Pacemakers and Defibrillators, Pulmonary functions measurement, Patient monitoring systems, Ventilators, Electric shock hazards and prevention.

## Chemical Engineering (Weightage 50%) (Subject Specific)

### Unit 1

**Chemical Process Calculations and Chemical Engineering Thermodynamics:** Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

### Unit 2

**Momentum Transfer:** Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis and similitude, shell balances, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

### Unit 3

**Mechanical Operations:** Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

### Unit 4

**Process Heat Transfer:** Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

### Unit 5

**Mass Transfer:** Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

### Unit 6

**Chemical Reaction Engineering:** Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

### Unit 7

**Environmental Engineering:** Importance of environment. Damages due to environmental pollution.

Types of water pollutants, treatments of effluents, Sludge treatment and disposal.

Classification of air pollutants. Effects of air pollution, control methods for particulates, gaseous pollutants. Pollution abatement equipment used in Process industries.

Engineered systems for solid waste management – Generation and handling, Composting, sanitary land filling and incineration.

### **Unit 8**

**Instrumentation and Process Control:** Measurement of process variables; sensors, transducers and their dynamics, process modelling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots), controller tuning, cascade and feed forward control.

### **Unit 9**

**Plant Design and Economics:** Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors.

### **Unit 10**

**Chemical Technology:** Inorganic chemical industries (sulphuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

## Chemistry (Weightage 50%) (Subject Specific)

### Inorganic Chemistry

#### Unit 1

**Atomic structure and periodic properties:** Quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli's exclusion principle. Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity and electronegativity in the periodic table.

#### Unit 2

Errors: Classification, minimization of determinate errors, accuracy and precision. Significant figures and their computations.

### Organic Chemistry

#### Unit 3

**Bond cleavage** – homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes – explanation for stability and based on inductive, resonance and hyperconjugation effects.

#### Unit 4

**Types of reactions** - addition, substitution and elimination. Concept of isomerism – Structural isomerism, stereo isomerism - geometrical and optical isomerism.

**Chemistry of Aliphatic and aromatic Hydrocarbons Alkanes:** Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and Unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and Demerits.

**Cycloalkanes:** Nomenclature. Method of formation. Explanation for stability based on Hydrogenation data, Baeyer's strain theory and its limitation, Sachse -Mohr theory of strainless rings; cyclopropane ring - banana bonds.

**Alkenes:** Preparation of alkenes by Wittig reaction-stereo selectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with Mechanism. Reactions: Hydroboration- oxidation, reduction.

**Alkynes:** Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with  $\text{KMnO}_4$ , acidic nature of terminal synthesis and reactions of alcohols, phenols Amines & Aldehydes & ketones.

Aromaticity ;Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect.

### Physical Chemistry

#### Unit 5

**Thermodynamics** : Deviation of real gases from the equation of state for an ideal gas, van der Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases.

Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

### **Unit 6**

**Phase rule and its applications :** Equilibrium between liquid, solid and vapours of a pure substance, Clausius-Clapeyron equation and its applications. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water ) and two components (lead-silver). Distribution law, its modifications, limitations and applications.

### **Unit 7**

**Solutions :** Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's laws, fractional and steam distillations.

### **Applied Chemistry**

### **Unit 8**

**Instrumental Methods of Analysis:** UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.

### **Unit 9**

**Organic and Inorganic Polymers:** Differences between inorganic and organic polymers. Polymerisation: types: addition and condensation polymerization, Molecular weight of Polymers: Expression for Weight average and Number average (experimental determination is not required) Preparation and applications of the following types of polymers

1. Plastics: i) Thermosetting plastics (Phenol-formaldehyde)  
ii) Thermo softening plastics (PVC)
2. Fibers: Acrylic, polyamide, polyester types: one example for each
3. Rubber: Neoprene,
4. Fluoro Carbons: Teflon
5. Silicones.

### **Unit 10**

**Environmental Chemistry:** Air pollution, types of air pollutants; control of air and water pollution Depletion of ozone in the stratosphere. Causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

### **Reference Books:**

1. Concise Inorganic Chemistry, J.D. Lee, Fifth Edition, John Wiley and Sons Ltd.
2. Advanced Inorganic Chemistry - Vol. 1 & Vol. 2, Satya Prakash et al, S. Chand Publication.
3. Organic Chemistry, Morrison and Boyd, Sixth Edition, Pearson Publication.
4. Physical Chemistry, Peter Atkins and Julio de Paula, 10<sup>th</sup> Edition, Oxford Publication.
5. Fundamentals of Analytical Chemistry, Skoog et al, 8<sup>th</sup> Edition, Thomson Publishers.
6. Polymer Science, V. R. Gowariker et al, Third Edition, New Age International Publishers.
7. Environmental Chemistry, Anil K. De, 9<sup>th</sup> Edition, New Age International Publishers.

## CS/IS (Weightage 50%) (Subject Specific)

### Unit 1

**Data Structures and its applications:** introductions, primitive, arrays, strings, stacks recursion, queues, linked lists, trees, sorting and searching

Reference:

1. Erns Horowitz and Sartaj Salmi, Fundamentals of Data Structures in C, Universities Press,
2. Seymour Lipschutz, Data Structures Schaum's Outlines, McGraw 11111

### Unit 2

**Discrete Mathematical Structures: Fundamentals of logics, properties** of Integers, principles of counting, relations and functions, inclusion and exclusion, graph theory

Reference: Ralph P, Grimaldi: Discrete and Combinatorial Mathematics, Pearson Education.

### Unit 3

**Software Engineering: introduction, requirement engineering,, RUP, UML, software**

*testing, project planning, agile software development. Reference: Ian*

*Sommerville: Software Engineering,, Pearson Education*

### Unit 4

**Computer Organization: Machine instructions and programs, input/output organization, memory, Arithmetic, and basic processing unit**

Reference: Carl Hamacher, honk<sup>o</sup> Vranesic, Safwat Zaky, Computer Organization, 5th Edition, Tata McGraw Hill, 2002

### Unit 5

**Design and Analysis of Algorithms: introduction to algorithms, performance, divide and conquer, greedy, dynamic programming, backtracking**

Reference:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin. Pearson.
2. Computer Algorithms/C4—I., Ellis Horowitz, Shirai Salmi and Rajasekaran,Universiuts Press

### Unit 6

**Operating system: introduction, multi threaded programming, Deadlocks, virtual memory management, secondary storage structures and protections,**

Reference: Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles , Wiley-India.

### Unit 7

**Data Communication and Computer Network; Introduction, Digital transmission, bandwidth utilization, Data link control, media access control, wired LAN and Ethernet. Application layer, Transport layer, Network layer, Network security**

Reference: Behr= A, Forouzan, Data Communications and Networking

James F Kurose and Keith W Ross, Computer Networking, A Top•Down Approach, Sixth edition, Pearson

## **Unit 8**

**Object Oriented Modelling and Design(c++/Java): Introduction, use case modelling, Process overview, use case realization, Design patterns**

Reference: 1. Michael Olaha, James Rumbaugh: Object Oriented Modelling and Design with UML, Pearson Education

2.Erich Gamma. Richard Helm. Ralph Johnson and John Vlissides: Design Patterns —Elements of Reusable Object-Oriented Software, Pearson Education

## **Unit 9**

**Data Base Management System: Introduction, relational model, Relational algebra, SQL, Normalization, transaction processing, External Sorting.**

Reference: Fundamentals of Database Systems, Ram/. Elmasri and Shamkant II, Navathe,, Pearson,

## **Unit 10**

**System modelling and simulation: introduction, statistical modelling, queuing models, random number generation, input modelling, estimation, verification, calibration and validation.**

Reference: Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation,

## **Civil Engineering (Weightage 50%) (Subject Specific)**

### **Unit 1**

**Structural analysis:** Structural systems, Truss analysis, Deflection of beams, Strain energy, Arches and cables.

### **Unit 2**

**Fluid mechanics:** Open channel flow, Pipe flow and water hammer, Dimensional analysis and model studies, Impact of jets on vanes, Pumps & turbines.

### **Unit 3**

**Concrete technology:** Properties of fresh and hardened concrete, Special concretes, Non destructive testing of concrete.

### **Unit 4**

**Design of concrete structures:** Principles of limit state design, Design of beams, Design of slabs Design of columns.

### **Unit 5**

**Geotechnical engineering:** Index properties of soil, Soil structure & classification of soils, Compaction of soil, Soil water system, Consolidation of soils, Effective stress and shear strength Ground modifications.

### **Unit 6**

**Transportation engineering:** Highway planning and alignment, Highway geometric design, Pavement material and construction, Wind analysis and site selection for airport, Pavement of evaluation.

### **Unit 7**

**Irrigation engineering:** Water requirements of crops, Canal cross drainage work, Gravity dams and earthen dams.

### **Unit 8**

**Design of Steel structures:** Steel structural fasteners, Tension, compression, flexural members Connections.

### **Unit 9**

**Environmental engineering:** Population forecasting, Water quality, Water treatment, Methods of sanitation, Sewage treatment and industrial waste water treatment.

### **Unit10**

**Surveying:** Compass surveying, Leveling and contouring, Theodolite survey, Curve settings, Areas & volumes, Total station survey.

## **ELECTRICAL AND ELECTRONICS ENGINEERING (Weightage 50%) (Subject Specific)**

### **Unit – 1**

#### **Network Analysis and Field Theory**

**Network Theory:** Nodal analysis, Thevenin's and Norton's theorem, maximum power theorem, Two port network – Z, Y and transmission line parameters. Series and parallel Resonance.

**Electrostatics:** Coulomb's law, Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem.

**Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials.

**Time varying fields and Maxwell's equations:** Faraday's law, Displacement current. Maxwell's equations in point form and integral form.

### **Unit – 2**

#### **Analog and Digital Circuits**

**Transistor frequency response:** General frequency considerations, low frequency response, Miller effect capacitance, high frequency response, multistage frequency effects.

**Feedback amplifiers:** Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits.

**Power amplifiers:** Amplifier types, analysis and design of different power amplifiers, distortion in power amplifiers.

**Oscillators:** Principle of operation, analysis and derivation of frequency of oscillation of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator and frequency stability.

**Analysis and design of combinational logic circuits** - Decoders-BCD decoders, Encoders. Digital multiplexers-using multiplexers as Boolean function generators. Adders and Subtractors-Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics.

**Sequential Circuits:** Basic Bistable element, Latches, SR latch, application of SR latch, A Switch debouncer, The SR latch, The gated SR latch. The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The master-slave SR Flip-Flops, The master-slave JK Flip-Flop, Edge Triggered Flip-flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop. Characteristic equations, Registers, Counters-Binary Ripple Counter, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod-6 counters using clocked JK Flip-Flops Design of a Synchronous Mod-6 counter using clocked D, T, or SR Flip-Flops.

### **Unit – 3**

#### **Microcontroller and Operational Amplifiers**

**8051 programming in C:** Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C

**8051 Timer programming in Assembly and C:** Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C.

**8051 Interrupt programming in assembly and C:** 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C.

**ADC, DAC and sensor interfacing:** ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning.

**Comparators & Converters:** Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters.

**A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC, dual slope ADC, digital ramp ADC.

**Phase Locked Loop (PLL):** Basic PLL, components, performance factors, applications of PLL IC 565.

**Timer:** Internal architecture of 555 timer, Mono stable, Astablemultivibrators and applications.

#### **Unit – 4**

**Signals and processing:** Continuous-time Fourier transform, Discrete-time Fourier transform, Z-transform, Design of IIR and HR filters.

#### **Unit – 5**

##### **Electrical Machines**

**Transformers:Equivalent** circuit, Open circuit and Short circuit tests, calculation of **equivalent** circuit parameters and predetermination of efficiency- commercial and all-day. Voltage regulation and its significance. Necessity of Parallel operation, conditions for parallel operation – Single phase and three phase. Load sharing in case of similar and dissimilar transformers.

**Synchronous generators:** Synchronous generator on infinite bus-bars – General load diagram, Electrical load diagram, Power angle characteristic and synchronizing power. Open circuit and short circuit characteristics, Voltage regulation by EMF, MMF and ZPF. Load sharing.

**DC Motors:** Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, series and compound motors. Speed control of shunt, series and compound motors.

**Three-phase Induction Motor:** Phasor diagram of induction motor on no-load and on load, equivalent circuit, losses, efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling. Speed control by voltage frequency, and rotor resistance methods

#### **Unit – 6**

**Control systems:** Time domain Analysis, Routh Stability Criterion, Root locus, Bode and Nyquist plots.

#### **Unit – 7**

##### **Power Electronics**

**Controlled Rectifiers:**Introduction, Single-Phase Full Converters, Single-Phase Dual Converters, Three-Phase Full Converters, Three-Phase Dual Converters.

**AC Voltage Controllers:** Introduction, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers.

**DC-DC Converters:** Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification.

**DC-AC converters:** Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.

#### **Unit – 8**

##### **Transmission lines and fault analysis**

**Performance of Transmission lines:** Short, medium and Long, ABCD constants. Calculation of inductance and capacitance of lines. Overhead line insulators, Corona.

**Fault Analysis:**Symmetrical and unsymmetrical faults.

#### **Unit – 9**

##### **High Voltage Engineering and Power System Protection**

**Conduction and Breakdown:** Townsend's Criterion for Breakdown, Breakdown in Electronegative Gases, Time Lags for Breakdown, Paschen's Law, Conduction and Breakdown in Pure and commercial Liquids. Intrinsic, Electromechanical and Thermal Breakdown in solid dielectrics.

**Generation of High Voltages and Currents:** Generation of High Direct Current Voltages, Alternating Voltages, Impulse Voltages, Impulse Currents.

**Overvoltage Phenomenon and Insulation Coordination:** Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges. Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.

**Overcurrent Protection:** Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.

**Circuit Breakers:** Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Air – Blast Circuit Breakers, SF<sub>6</sub> Circuit Breakers, Vacuum Circuit Breakers.

**Protection against Overvoltages:** Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).

## **Unit – 10**

### **Load Flow Studies and Power System Operation and Control.**

**Load Flow Studies:** Introduction, Network Model Formulation, Formation of  $Y_{bus}$  by Singular Transformation, Load Flow Problem, Gauss-Seidel Method. Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile.

**Optimal System Operation:** Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling.

**Automatic Generation Control in interconnected Power system:** Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models. State-Space Model for Two - Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC.

**Voltage and Reactive Power Control:** Production and Absorption of Reactive Power, Methods of Voltage Control, Dependence of Voltage on Reactive Power, Sensitivity of Voltage to Changes in P And Q, Cost Saving, Methods of Voltage Control by Reactive Power Injection, Voltage Control Using Transformers, Voltage Stability.

## Electronics and Communication (Weightage 50%) (Subject Specific)

### Unit 1

**Networks:** Network theorems; Superposition, Thevenin's and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis; Time domain analysis of simple linear circuits; Transients, Resonance – Series and Parallel Resonance Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks.

### Unit 2

**Signals and Systems:** Continuous-time signals; Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: Various types, discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

### Unit 3

**Electronic Devices:** Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS Capacitor, MOSFET, SCR, IGBT, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process. Thick and thin film techniques.

### Unit 4

**Analog Circuits:** Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation. Voltage Regulators.

### Unit 5

**Digital Circuits:** Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, Logic Families, logic gates, CMOS implementations, Logic gates, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM and DRAM. Cache Memories. Sensors, Transducers – Display Devices – LED and LCDs.

### Unit 6

**Control Systems:** Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; error coefficient, steady state error, Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems, Closed loop response - M & N Circles, Nichols Chart. Basics of Non Linear controls, Industrial Automation and Robotics.

## Unit 7

**Communications: Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems;**

Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem;

Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error detection correction and Hamming code; Basics of Spread spectrum communications, TDMA, FDMA, CDMA and OFDM.

CCN: Basics, Ethernet, Internet Relevant Protocols Services.

## Unit 8

**Electromagnetics: Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers, Dipole and Yagi antennas**

## Unit 9

**Computer Organization:** Organization and architecture. Computer components and functions. Various generations of computers. Addressing—Zero, single, two and three address machines. Hardwired and microprogramming. Arithmetic Circuits—Binary adder, subtractor, multiplier and divider circuits. Fast adder. BCD adder, Floating point representation and arithmetic operations.

I/O devices. RISC, CISC machines, Parallel computing and organization.

## Unit 10

**Microprocessor and Microcontrollers:** Microprocessor family. Evolution, advances in architecture. 8086 processor—Architecture, pin details, functions, Instruction set, assembler directives, Simple programs. Interrupts and interrupt handling.

I/O and memory interfacing. Buses—RS232 and USB.

Microcontroller—8051, architectural details, Instruction sets, Interrupts, Programming

Arm Processor-Basics. Embedded system

**Electronics & Instrumentation Engineering / Instrumentation Technology**  
**(Weightage 50%) (Subject Specific)**

**Unit 1**

**Basic Electronics and Network Analysis:** Semiconductor diodes and applications, BJT, BJT biasing, DC load line and bias point, base bias, Voltage divider bias.  
Basic concepts network analysis, Nodal analysis, Mesh analysis, Network theorems, Transient behavior and Initial conditions, Two port network parameters, Resonant circuits, Network topology.

**Unit 2**

**Analog Electronics and Signal Conditioning Circuits:** BJT AC analysis, FET, MOSFET, FET biasing, FET amplifiers, BJT and FET frequency response, Feedback and Oscillator circuits.  
Op-amp characteristics and applications, Integrator, differentiator, Wave shaping circuits, F to V and V to F converters, Active filters, Schmitt trigger, Phase locked loop, 555 timers, Analog to Digital converters and Digital to Analog converters.

**Unit 3**

**Digital Design and HDL:** Switching and Logic Levels, Number systems, Number conversion, Boolean algebra and minimization techniques, Combinational circuits, Sequential circuits, Counters and shift registers, Analysis and design of digital circuits using HDL (Verilog).

**Unit 4**

**Microcontrollers:** Introduction to Microcontrollers-8051 for embedded systems, Architecture and register set of 8051, Addressing modes, Instruction set of 8051-Data transfer instructions, Arithmetic instructions, logical instructions, bit and byte level control transfer instructions, 8051 assembly programming-stack operations, subroutines, interrupt, 8051 programming as timer/counter, 8051 serial communication, 8051 interfacing RS-232, LED, Stepper motor.

**Unit 5**

**Instrumentation and Measurement Systems:** Measurement and instrument, Functions and applications of measurement system, Types of instruments, Generalized Instrumentation and Measurement system, Static and Dynamic Characteristics.  
Measurement errors, Ammeter, voltmeter, multimeter, Digital voltmeter, Digital instruments, Oscilloscope, digital oscilloscopes, Signal generators, Bridge circuits for measurement of R, L, and C. Display devices and recorders, Frequency measurements and phase measurements.

**Unit 6**

**Transducers and Process Instrumentation:** Transducers, Classification of transducers, transducers/sensors for the measurement of Displacement, Level, Strain, Force, Torque, Pressure, Temperature, Flow, Vibration Viscosity, Humidity and Moisture.

**Unit 7**

**Control Systems, Process Control and Automation:** Basics of control systems, Block diagram Reduction, Signal flow graph, Time response analysis, Concepts of stability, Nyquist criteria, Root locus technique, and Bode plot.  
Introduction to process control and final control operations, Controller principles (all types of continuous and discontinuous controllers), Analog controllers, Control loop characteristics.  
PLC instructions, Timers and counters instruction, Data handling Instructions, Distributed Digital Control, Supervisory Control and data acquisition System.

### **Unit 8**

**Fundamentals of Signals and DSP:** Introduction to signal and systems, Z-transform and its application to analysis of LTI systems, realization of Digital systems, DFT: Properties and Applications, IIR and FIR filters, Multirate Digital Signal Processing & Adaptive Filters.

### **Unit 9**

**Power Electronics and Communication Systems:** Thyristors, Controlled Rectifiers, Choppers, Inverters.

Amplitude modulation, Angle modulation, Pulse modulation, Digital Band-Pass Modulation Techniques.

### **Unit 10**

**Analytical, Biomedical and Optical Instrumentation:** Basics of analytical instrumentation, IR Spectroscopy, UV and Visible Spectroscopy, Flame emission and Atomic Absorption spectroscopy, Gas chromatography, HPLC.

Bioelectric signals and electrodes, Electrocardiograph, Electroencephalograph, Electromyograph, Blood pressure Measurement, Blood Flow Measurements, Cardiac Pacemakers and Defibrillators.

Lasers and generation of lasers, Applications of lasers.

## **Mechanical Engineering\_(Weightage 50%) (Subject Specific)**

### **Unit 1**

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses.

### **Unit 2**

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope. Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

### **Unit 3**

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

### **Unit 4**

Fluid Mechanics and Thermodynamics: Fluid properties; fluid statics, manometry, buoyancy, stability of floating bodies; Bernoulli's equation; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; availability and irreversibility.

### **Unit 5**

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, heat transfer through fins; unsteady heat conduction, lumped parameter system, thermal boundary layer, free and forced convective heat transfer, effect of turbulence; heat exchanger performance; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors.

### **Unit 6**

Power Engineering: Air compressors; vapour and gas power cycles, concepts of regeneration and reheat.

I.C. Engines: Air-standard Otto, Diesel and dual cycles.

Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

### **Unit 7**

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

### **Unit 8**

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials, principles of powder metallurgy

### **Unit 9**

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design.

Principles of welding, brazing, soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes.

### **Unit 10**

Management, economics and operations research:

Management and administration, Roles of management, levels of management, modern management approaches, Planning, steps in planning and planning premises, Hierarchy of plans; Principles of organization, nature and importance of staffing.

Cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource leveling.

Linear programming – simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models PERT and CPM, Markovian queuing models; dynamic programming; simulation – manufacturing applications.

## **Mining Engineering (Weightage 50%) (Subject Specific)**

### **Unit 1**

**Mine Development and Surveying:** Methods of access to deposits; Underground drivages; Drilling methods and machines; Explosives, blasting devices and practices.

Levels and leveling, theodolite, tacheometry, triangulation; Contouring; Errors and adjustments; Correlation; Underground surveying; Curves; Photogrammetry; Field astronomy; EDM and Total Station; Introductory GPS .

### **Unit 2**

**Geomechanics and Ground Control:** Equivalent force systems; Equations of equilibrium; Two dimensional frames and trusses; Free body diagrams; Friction forces; Particle kinematics and dynamics; Beam analysis.

Geo-technical properties of rocks; Rock mass classification; Instrumentation and stress measurement techniques; Theories of rock failure; Ground vibrations; Stress distribution around mine openings; Subsidence; Rock bursts and coal bumps; Slope stability.

Design of pillars; Roof supporting systems; Mine filling.

### **Unit 3**

**Mining Methods:** Surface mining: layout, development, loading, transportation and mechanization, continuous surface mining systems; Underground coal mining: bord and pillar systems, room and pillar mining, longwall mining, thick seam mining methods; highwall mining; Underground metal mining: open, supported and caved stoping methods, stope mechanization, ore handling systems.

### **Unit 4**

**Mining Machinery:** Generation and transmission of mechanical, hydraulic and pneumatic power; Materials handling: haulages, conveyors, face and development machinery, hoisting systems, pumps, crushers.

### **Unit 5**

**Surface Environment:** Air, water and soil pollution : Standards of quality, causes and dispersion of contamination, and control; Noise; Land reclamation.

### **Unit 6**

**Mine Ventilation:** Underground atmosphere; Heat load sources and thermal environment, air cooling; Mechanics of air flow, distribution, natural and mechanical ventilation; Mine fans and their usage; Auxiliary ventilation; Ventilation planning; Ventilation networks.

### **Unit 7**

**Subsurface Hazards:** Mine Gases. Underground hazards from fires, explosions, dust and inundation; Rescue apparatus and practices; Safety in mines; Accident data analysis; Mine lighting; Mine legislation; Occupational safety.

### **Unit 8**

**Mine Economics:** Mineral resource classification; Discounted cash flow analysis; Mine valuation; Mine investment analysis; Mineral taxation.

**Unit 9**

**Mine Planning:** Sampling methods, practices and interpretation; Reserve estimation techniques: Basics of geostatistics and quality control; Optimization of facility location; Work-study.

**Unit 10**

**Systems Engineering:** Concepts of reliability; Reliability of simple systems; Maintainability and availability; Linear programming, transportation and assignment problems; Network analysis; Inventory models; Queueing theory; Basics of simulation.

## **Marine Engineering (Weightage 50%) (Subject Specific)**

### **Unit 1**

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses.

### **Unit 2**

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

### **Unit 3**

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

### **Unit 4**

Fluid Mechanics and Thermodynamics: Fluid properties; fluid statics, manometry, buoyancy, stability of floating bodies; Bernoulli's equation; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; availability and irreversibility.

### **Unit 5**

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, heat transfer through fins; unsteady heat conduction, lumped parameter system, thermal boundary layer, free and forced convective heat transfer, effect of turbulence; heat exchanger performance; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors.

### **Unit 6**

Power Engineering: Air compressors; vapour and gas power cycles, concepts of regeneration and reheat. Marine heat engines.

Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines. Steam and gas turbines

### **Unit 7**

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

**Unit 8**

Stresses in ship structure: Bottom and side framing, Fore-end arrangements, after-end arrangements; Shell and Decks; Bulkheads and Deep tanks; Ship insulation, corrosion control and antifouling system surface preparation and painting.

Marine corrosion and prevention: Corrosion and degradation of metals; Electrode kinetics and polarization phenomenon; Corrosion in marine diesel engines; Prevention of corrosion

**Unit 9**

Geometry of ship and Hydrostatic calculations, ship lines, pressure exerted by a liquid, load on immersed plane, hydrostatic curves of ship; T.P.C, Co-efficient of forms: Center of gravity, stability of ships; TRIM; Propeller and Rudder theory, force on rudder

**Unit 10**

Management and administration, Roles of management, levels of management, development of management, modern management approaches, Planning, steps in planning and planning premises, Hierarchy of plans; Principles of organization, types of organization, nature and importance of staffing  
Entrepreneur: Functions of an Entrepreneur, Types of Entrepreneur, Stages in entrepreneurial process;  
Small Scale Industries: Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study

## **Mechatronics Engineering\_(Weightage 50%) (Subject Specific)**

### **Unit 1**

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses.

### **Unit 2**

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.  
Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

### **Unit 3**

Fluid Mechanics and Fluid machines: Fluid properties; fluid statics, manometry, buoyancy, stability of floating bodies; Bernoulli's equation; Dimensional Analysis; Fluid Flow Measurements.  
Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; Steam Turbines  
Hydraulics and pneumatics: Hydraulic actuators and motors; control components in hydraulic systems; Hydraulic circuit design and analysis; safety circuit; structure of pneumatic control system; pneumatic control valves; signal processing elements; electro-pneumatic control

### **Unit 4**

Heat Treating of metals: TTT curves, Ferrous and non ferrous materials: Solidification and phase diagram: Mechanism of solidification, Homogenous and Heterogeneous nucleation. Crystal Growth, Cast metal structures, Phase diagram. Solid solutions; Composite materials: Processing of FRP Composites: Metal Matrix Composites: Smart Materials: Piezoelectric Materials, Electrostrictive materials; Smart Sensor, Actuator and Transducer Technologies

### **Unit 5**

Instrumentation and measurements: Functional Elements of Instrument/ measurement system; Static and Dynamic Characteristics; Measurement of Displacement; Measurement of Level; Measurement of Strain; Measurement of resistance, inductance and capacitance; Measurement of Force, Torque & Shaft Power: Temperature Measurement; Pressure Measurement; Flow Measurement

### **Unit 6**

Metal working: Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design.  
Introduction to metal working: Forging: Rolling: Drawing: Extrusion: Sheet & Metal Forming  
Advanced Welding processes Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW), Resistance welding,  
Non-traditional Machining Processes: Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.

## **Unit 7**

**Control Systems:** Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead etc.

## **Unit 8**

Analog & Digital Electronics :

Analog Circuits: Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis etc.

Digital Circuits: Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip flops etc.

## **Unit 9**

Robotics and automation: Types of robotics; Generations of robots; degrees of freedom; Asimov's laws of robotics; dynamic stabilization of robots.

Power Sources and Sensors; Hydraulic, pneumatic and electric drives variable speed arrangements ; path determination ; micro machines in robotics Manipulators, Actuators And Grippers; electronic and pneumatic manipulator control circuits

Industrial Automation: Basic Devices in Automated Systems; Different Controllers Employed In Automated Systems. Safety in Industrial Automation

Material handling and Identification Technologies Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.

## **Unit 10**

Automotive electronics: Automotive Fundamentals Overview: Four Stroke Cycle, Engine Control Ignition System, Spark plug, Spark pulse generation, Ignition Timing, Drive Train, Transmission, Brakes, Steering System, Battery, Starting System.

Air and Fuel Systems; Sensors and Actuators; Automotive Instrumentation and Communication: Vehicle Motion Control: Cruise control, Automotive Diagnostics; Expert Systems. Introduction to Alternative Vehicles: Electric Vehicle, Hybrid Electric vehicle, Electric Hybrid Vehicle, Alternative Vehicle Architecture: Electric Vehicles, Hybrid Electric Vehicles, Plug-in Hybrid Electric Vehicles, Power Train component Sizing, Mass Analysis & Packaging, Vehicle Simulation.

## **Industrial Engineering and Management (Weightage 50%) (Subject Specific)**

### **Unit 1**

**ENGINEERING MATERIALS AND HEAT TREATMENT:** Structure, Properties, and Applications of Engineering Materials (Metals, Ceramics, Polymers, and Composites), Phase diagrams, and Stress-Strain Diagrams for Engineering Materials. Various Heat Treatment Processes of Metals and Alloys.

### **Unit 2**

**FLUID MECHANICS AND BASIC THERMODYNAMICS:** Fluid Properties, Fluid statics, Manometry, Buoyancy, Forces on Submerged bodies and Stability of Floating Bodies. Zeroth, First, and Second Laws of Thermodynamics and their Applications. Basics of IC Engines.

### **Unit 3**

**MANUFACTURING PROCESSES AND MACHINE TOOLS:** Principles of Casting, Forging, Rolling, Extrusion, and Sheet metal Forming. Metal joining processes such as Welding, Brazing, and Soldering. Operation of Machine Tools like Lathe, Drilling Machine, Milling Machine, Grinding.

### **Unit 4**

**STATISTICS FOR ENGINEERS:** Basics of probability and sampling, Conditional probability, Mean, median, mode and standard deviation, variance, Random variables, Poisson, Normal, and Binomial distributions.

### **Unit 5**

**METROLOGY AND QUALITY MANAGEMENT:** Metrology and Inspection: Limits, Fits, Tolerances and Gauges. Fundamentals of Linear, angular, and Form measurements. Quality Management: Quality concepts and costs. Introduction to SQC, Acceptance Sampling, Six-Sigma, Total Quality Management (TQM), and ISO 9000.

### **Unit 6**

**INDUSTRIAL ENGINEERING:** Taylor's scientific management, Gilbreth's contributions; productivity – concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.

### **Unit 7**

**FACILITY PLANNING AND DESIGN:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems.

### **Unit 8**

**OPERATIONS RESEARCH:** Operations Research: Linear Programming, Simplex Method, Transportation, Assignment, and Game theory Problems. Network Analysis: PERT and CPM.

### **Unit 9**

**OPERATIONS MANAGEMENT:** Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; MRP, concept of JIT manufacturing system; Logistics, distribution, and supply chain management; Basics of Inventory control systems.

### **Unit 10**

**ENGINEERING ECONOMY AND COSTING:** Interest Factors, Present Worth, Annual Equivalent, and Pay back calculations. Methods of Depreciation, Basics of cost accounting, Break-even analysis, techniques for evaluation of capital investments.

## **Industrial and Production / Manufacturing (Weightage 50%) (Subject Specific)**

### **Unit 1**

**ENGINEERING MATERIALS AND HEAT TREATMENT:** Structure, Properties, and Applications of Engineering Materials (Metals, Ceramics, Polymers, and Composites), Phase diagrams, and Stress-Strain Diagrams for Engineering Materials. Various Heat Treatment Processes of Metals and Alloys.

### **Unit 2**

**FLUID MECHANICS AND BASIC THERMODYNAMICS:** Fluid Properties, Fluid statics, Manometry, Buoyancy, Forces on Submerged bodies and Stability of Floating Bodies. Zeroth, First, and Second Laws of Thermodynamics and their Applications.

### **Unit 3**

**INTERNAL COMBUSTION ENGINES:** IC Engines: Air-standard Otto, Diesel and dual cycles. Two stroke, Four stroke Petrol and Diesel Engines. IHP, BHP, FHP, and Various types of Efficiencies.

### **Unit 4**

**MANUFACTURING PROCESSES:** Principles of Casting, Forging, Rolling, Extrusion, and Sheet metal Forming. Metal joining processes such as Welding, Brazing, Soldering, and Adhesive bonding. Basics of Additive Manufacturing.

### **Unit 5**

**MACHINE TOOLS AND OPERATIONS:** Operation of Machine Tools like Lathe, Drilling Machine, Milling Machine, Grinding, Machine. Mechanics of Machining, Single and Multi Point Cutting Tools. Principles and types of Non-Conventional Machining Processes. Basic Concepts of CAD/CAM.

### **Unit 6**

**MACHINE DESIGN AND MECHATRONICS:** Design for Static and Dynamic Loading, Failure theories, Fatigue Strength and S-N diagram, Principles of Design of Machine Elements such as Bolted, Rivetted and Welded Joints, Shafts, Gears, and Springs. Power Transmission: Belt, Rope, chain, and Gear Drives. Introduction to Mechatronics: Open Loop and Closed Loop Control Systems.

### **Unit 7**

**QUALITY AND RELIABILITY:** Quality Management: Quality concepts and costs. Introduction to SQC, Acceptance Sampling, and Six-Sigma. Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; determination of system reliability.

### **Unit 8**

**METROLOGY AND MEASUREMENTS:** Limits, Fits, Tolerances and Gauges. Fundamentals of Linear, angular, and Form measurements. Inspection of screw threads and gears; surface finish measurement by contact and non-contact methods.

**Unit 9**

**OPERATIONS RESEARCH:** Operations Research: Linear Programming, Simplex Method, Transportation, Assignment, and Game theory Problems. Network Analysis: PERT and CPM. Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality.

**Unit 10**

**ENGINEERING ECONOMY AND COSTING:** Interest Factors, Present Worth, Annual Equivalent, and Pay back calculations. Methods of Depreciation, Basics of cost accounting, Break-even analysis, techniques for evaluation of capital investments.

## Mathematics (Weightage 50%) (Subject Specific)

### Unit 1

**LINEAR ALGEBRA** Matrices and determinants, Inverse of a matrix, rank of a matrix, consistency of a system of linear equations. Eigen values and eigen vectors

### Unit 2

**DIFFERENTIAL CALCULUS:** polar curves, angle between polar curves. Partial differentiation, maximum and minimum for function of single and two variables. Curvature and radius of curvature Taylor's and Maclaurin's expansion for a function of single variable. Indeterminate forms.

### Unit 3

**VECTOR CALCULUS:** Vector Differentiation-Scalar and vector point functions, Gradient of a scalar field, divergence and curl of a vector field. Vector integration-Green's theorem in the plane, Stokes and Gauss Divergence theorems

### Unit 4

**INTEGRAL CALCULUS:** Multiple integrals. Beta and gamma functions. Length, Area, Volume using multiple integrals.

### Unit 5

**ORDINARY DIFFERENTIAL EQUATIONS** Solutions of first order and first-degree differential equations (Exact and reducible to exact differential equations), Linear differential equations of higher order with constant coefficients-inverse differential operator, Cauchy's and Legendre's DE's.

### Unit 6

**PARTIAL DIFFERENTIAL EQUATIONS:** Formation of Partial differential equations (PDE). Solution of PDE: by direct integration, homogeneous and non-homogeneous with constant coefficients. Classification of second order Partial differential equations.

### Unit 7

**a) Infinite Series:** Convergence and divergence of series of positive terms, tests for convergence-ratio test and root test, problems.

**b) Fourier Series:** Dirichlet's conditions. Expansions of Periodic functions into Fourier series, Half range Fourier series

### Unit 8

**INTEGRAL TRANSFORM:** Laplace Transforms, & Fourier Transforms

### Unit 9

**NUMERICAL METHODS** Finite differences-Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals- Lagrange's formulae. Numerical differentiation using Newton's forward and backward difference formulae. Numerical Integration-Simpson's one-third, three-eighth and Weddles rule. Solutions of first order ODE's- Euler's modified method, Runge-Kutta fourth order method,

### Unit 10

**STATISTICS AND PROBABILITY** Correlation and regression, Probability : Recap of Random Variables. Discrete probability distributions- Binomial, Poisson and Geometric distributions; Continuous probability distributions-Exponential and Normal.

### Reference Books:

1. Higher Engineering Mathematics – Dr. B.S. Grewal (37th Edition)
2. Elementary Engineering Mathematics- Dr. B.S. Grewal
3. Advanced Engineering Mathematics –Erwin Kreyszig
4. Introduction to Numerical Analysis –S.S. Sastry

## **MBA (Weightage 50%) (Subject Specific)**

### **Unit 1:**

Management- Definition, Nature, Purpose and Functions; Principles of Management- Planning, Nature, Process, Types and Steps; Organizing- Structure, Span of Management, Centralization, Decentralization; Empowerment; Staffing – Overview; Directing and Controlling- Process, Types of Control; MBO ; Management Guru's, Management Theories, Managerial Grid.

### **Unit 2:**

Organization Behavior - Nature, Learning; Personality- Definition, Traits, Determinants; Attributes of Personality, Evolution & Organizational Behavior in India; Perception-Meaning, Factors Influencing Perception, Errors of Perception; Decision Making, Values and Attitudes, Motivation, Morale, Conflict, Negotiations & Stress Management, Power and Politics.

### **Unit 3:**

Managerial Economics – Meaning, Nature, Scope; Law of Demand – Elasticity of Demand, Law of Supply, Elasticity of Supply; Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition; Profits – Long term and Short term Profits; Cost Volume Profit Analysis, Break Even Point.

### **Unit 4:**

Accounting-Definition, Types of accounting; Accounting concepts and conventions of Accounting; Capital and Revenue Expenditure and Receipt; Accounting Equation; Human Resource Accounting, Forensic Accounting, Sustainability Reporting; Accounting Standards and International Financial Reporting System.

### **Unit 5:**

Marketing Management- Meaning, Importance, Marketing Management Process, Marketing Mix, Marketing Opportunities, challenges & Ethics, E-Marketing, Marketing Research, Marketing Process, Marketing Environment, Segmentation, Targeting, Positioning, Consumer Behaviour, Marketing Research, Demand Forecasting, Competition, Marketing Strategy, Customer Satisfaction.

### **Unit 6:**

Human Resource Management - Definition, Nature, Scope, Importance and Evolution of the concept of HRM, Managerial and operative functions of HRM- Man power Planning, Recruitment, Selection, Training and Development, Performance Management System, HR Competency.

### **Unit 7:**

Financial Management - Definition, Scope, Functions, Objectives, Time Value of Money; Financial Markets; Financial Instruments, Financial Institutions and Financial Services, Behavioural Finance.

### **Unit 8:**

Business Statistics- Definition, functions, scope; Measures of Central Tendency - Mean, Median, Mode, Geometric Mean, Harmonic Mean. Measures of dispersion: Range – Quartile Deviation, Standard Deviation. Research Methodology - Sampling and data collection, Definition, Types of sampling, Meaning of data, types of data, Methods of data collection, Time Series Analysis.

**Unit 9:**

Entrepreneurship – Meaning, Functions, Types; Business Planning – Process, Types of plans; Institutions Supporting Entrepreneurs – SIDBI, NABARD, IDBI, SIDCO; Venture Capital in India – Nature, Importance, Process; Social Entrepreneurship – Need, types, Make In India, Smart India, Digital India, EDI.

**Unit 10:**

Business Research-Definitions, Nature, Scope; Research Process, Research Design, Exploratory Research, Primary, Secondary Data Collection and Analysis, Hypothesis Formulation, Questionnaire Construction, Basic Scales, Sampling, Data Preparation and Preliminary Analysis, Factor Analysis, Regression Analysis, Cluster Analysis, Conjoint Analysis, Reporting and Concluding Integration.

## **MCA (Weightage 50%) (Subject Specific)**

### Unit 1

Data Structures: Stack: Definition, Representation, Stack as ADT, Operations and Applications: Polish and reverse polish expressions, Infix to postfix conversion, evaluation of postfix expression, infix to prefix, postfix to infix conversion; Recursion - Factorial, GCD, Fibonacci Sequence, Tower of Hanoi. Queue: Definition, Representation, Queue as ADT, Operations, Queue Variants: Circular Queue, Priority Queue, Double Ended Queue; Applications of Queues. Linked lists: singly linked list, doubly linked and its applications. Trees, sorting and searching and its applications.

### Unit 2

Discrete Mathematical Structures: Propositional logic, equivalences, Sets and set operations, Function definition and representation, types of function. Permutations, combinations, Graphs, terminology and special types of graphs, representation of graphs and its applications.

### Unit 3

Operating Systems Management: Process Management and Mutual Execution: Process, Process States, Process Description, Process Control, Execution of the Operating System, Security Issues, Processes and Threads, Symmetric Multi-processing (SMP), Microkernels. CPU Scheduler and Scheduling. Principles of Concurrency, Mutual Exclusion: Hardware Support, Semaphores, Monitors, Message Passing, Readers/Writes Problem.

Dead Lock: Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, deadlock Detection, An Integrated Deadlock Strategy, Dining Philosophers Problem. Memory Management: Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with Paging, demand paging Process Creation, Page Replacement, Allocation of Frames, Thrashing.

### Unit 4

Database Management System: Relational Model :Relational Model and Relational Algebra: Relational Model Concepts, Relational Model Constraints, Relational Model Constraints and Relational Database Schema Update Operations, Transactions and Dealing with Constraint violations, Unary Relational operations, Relational Algebra Operations from Set Theory, Binary Relational Operations, JOIN and DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra Relational Database Design Using ER-to-Relational Mapping.

Transaction Management:

Transaction Concept, A Simple Transaction Model, Transaction Atomicity and Durability, Serializability, Transaction Isolation and Atomicity, Transaction Isolation Levels, Implementation of Isolation Levels. Concurrency Control: Lock Based Protocols, Deadlock Handling. Recovery System: Failure Classification, Storage, Recovery and Atomicity, Recovery Algorithm.

### Unit 5

Analysis and Design of Algorithm: Introduction, Fundamentals of the Analysis of Algorithm Efficiency

Notion of Algorithm, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental data Structures. Analysis Framework, Asymptotic Notations and Basic efficiency classes, Mathematical analysis of Recursive and Non-recursive algorithms.

## Unit 6

Object Oriented Analysis and Design: What is Object Orientation? What is OO development? OO themes; Evidence for usefulness of OO development; OO modeling history. Modeling as Design Technique: Modeling; abstraction; The three models. Object and class concepts; Link and associations concepts; Generalization and inheritance; A sample class model; Navigation of class models; Advanced object and class concepts; Association ends; N-array associations; Aggregation; Abstract classes; Multiple inheritance; Metadata; Reification; Constraints; Derived data; Packages;

## Unit 7

Computer organization: Binary Systems and Combinational Logic Digital Computers and Digital Systems. Binary Numbers, Number Base Conversion, Octal and Hexadecimal Numbers, subtraction using 1's and 2's complements, Binary Code, Binary Storage and Registers, Binary Logic, Integrated Circuits. Digital Logic Gates, The map Method, Two- and Three-Variable Maps, Four-Variables Map.

Arithmetic Circuits and Sequential Logic NAND and NOR Implementation, Other Two-Level Implementations, Don't Care Conditions. Introduction, Adders, subtractors, binary Parallel Adder, Decimal Adder, Magnitude Comparator, Decoders, Multiplexers, BOOTH's algorithm for signed numbers with example.

## Unit 8

OOPs with C++: The Origins of C++, What Is Object-Oriented Programming? Encapsulation, polymorphism, Inheritance. Some C++ Fundamentals, A Sample C++ Program, A Closer Look at the I/O Operators, Declaring Local Variables, No Default to int, The bool Data Type, Old-Style vs. Modern C++, The New C++ Headers, Namespaces, Working with an Old Compiler, Introducing C++ Classes, Function Overloading, Operator Overloading, Inheritance Constructors and Destructors.

Classes and Objects: Classes, Structures and Classes Are Related, Unions and Classes Are Related, Anonymous Unions, Friend Functions, Friend Classes, Inline Functions, Defining Inline Functions Within a Class Parameterized Constructors, Constructors with One Parameter: A Special Case Static Class Members, Static Data Members, Static Member Functions, When Constructors and Destructors Are Executed, The Scope Resolution Operator, Nested Classes, Local Classes, Passing Objects to Functions, Returning Objects.

## Unit 9

Software Engineering: Introduction: Professional Software Development Attributes of good software, software engineering diversity, IEEE/ ACM code of software engineering ethics, case studies. Software Process models: waterfall, incremental development, reuses oriented, Process activities; Coping with change, The rational Unified process.

Agile methods, Plan-driven and agile Development, Extreme Programming, Agile project management, Scaling agile methods

## Unit 10

Computer Networks: Networking Devices, Classification of Computer Networks, Network Protocol Stack (TCP/IP and ISO-OSI), Network Standardization and Examples of Networks. Data Transmission Concepts, Analog and Digital Data Transmission, Communication media, Digital modulation techniques (FDMA, TDMA, CDMA).

DNS: Domain Name Space, Domain Resource Records, Domain Name Servers. Electronic mail: SMTP, The World Wide Web: Static and dynamic web pages, web applications, HTTP, mobile web. Streaming audio and Video: Digital audio and video, streaming stored and live media, Content delivery: Content and internet traffic, content delivery networks, peer-to-peer networks.

## Nanotechnology (Weightage 50%) (Subject Specific)

### Unit 1

**Introduction to Nanoscience and Nanotechnology:-** Importance and interdisciplinary nature of nanoscience and nanotechnology, 0D, 1D & 2D nanomaterials, size effects: surface to volume ratio, atomic, molecular & crystal structure, classification of phases & properties of materials, density of states & electronic energy bands- conductors, semiconductors and insulators, quantum effects in nanoscale materials. **Properties of materials at Nanoscale:-** Physical properties: Mechanical, Thermal, Electrical, Electronic, Magnetic and Superconducting, Optical properties & Coupled properties (Electromagnetic, ferroic properties, etc.)

### Unit 2

**Principles in Nanomaterial synthesis:-** Bottom-Up and Top-Down approach, Mechanisms involved in nano-synthesis: Fundamentals of thermodynamics: Laws of thermodynamics (zeroth, first, second & third laws). Statistical processes, diffusion (Fick's laws), Heat capacity. Phase transformation, Nucleation processes (Homogeneous & Heterogeneous). Basics of chemical kinetics, Catalysis.

### Unit 3

**Synthesis methods for nanomaterials:** Chemical precipitation, Sol-gel, Chemical reduction, Sonochemical synthesis, Hydrothermal, Solvothermal, Solution combustion, Super-critical fluid. Spin coating & Ball milling. Lithography techniques and Nanofabrication. Biological methods- Synthesis using micro organisms, Synthesis using plant extract, use of proteins and DNA templates.

### Unit 4

**Sofisticated methods for thin film deposition:** Physical vapour deposition (PVD): Thermal evaporation, Electron beam evaporation, Sputtering & electric arc, Laser ablation, Atomic layer deposition. Chemical vapor deposition (CVD): Closed/open reactor CVD, High & low pressure CVD, High & low Temperature CVD, Metal organic (MO) CVD, Hybrid Methods.

### Unit 5

**Structure and morphology Characterization Techniques:-** **Structural** characterisation: X-ray, Neutron & Electron diffraction. Surface & interface characterization techniques- Optical microscopy. Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Electron Energy Loss Spectroscopy (EELS), Atomic Force Microscopy (AFM), Scanning Tunnelling Microscopy (STM), Adsorption-desorption isotherms.

### Unit 6

**Elemental and compositional Characterization Techniques:-** Energy Dispersive X-ray Analysis (EDAX), Thermal characterisation: Thermo Gravimetric Analysis, DTA & Differential Scanning Calorimetry, Secondary Ion Mass Spectrometry, Dynamic Light Scattering (DLS), photoluminescence, X-ray Photoelectron Spectroscopy (XPS).

### Unit 7

**Spectroscopy and other special techniques:** Spectroscopy: Fourier Transform Infrared (FTIR), Raman, UV-Visible, EPR, NMR & Moessbauer Spectroscopy, Electrical characterisation: Four probe I-V characterisation, scanning tunneling spectroscopy, Mechanical testing: using Universal Testing Machine. Impedance spectroscopy, Contact angle measurement, Zeta potential. SQUID magnetometry.

## Unit 8

**Advanced Smart Nanomaterials:-** Carbon Based Nanostructures: Carbon Nanotubes (CNTs), Graphene, Fullerenes, Carbon clusters. Smart fluids (magneto-and Electro-rheological fluids), Polymeric materials, Metal & Metal oxide nanomaterials, Core-Shell nanostructures, Meta (Electromagnetic) materials, Nanocomposite materials, Glasses, Glazes & other ceramics.

## Unit 9

Applications of nanomaterials: applications based on anisotropic, Giant & Colossal magneto-resistance and Super-paramagnetism; Spintronics, Dielectric, Piezoelectric, Pyroelectric, Multiferroics. Ferromagnetic & Ferroelectric memory devices. P-N junctions, Lasers, Photodectors, Field Effect Transistors, High Electron Mobility Transistors. Energy Systems: Photovoltaics (Solar cells), Batteries & Fuel cells, Supercapacitors, catalysts. Powder metallurgy & processing, Mechanical alloying, Anti-corrosion coatings & Super hydrophobic surfaces.

## Unit 10

Biological nanomaterials: Proteins, DNA, Nanomedicine, Nanomaterials for targeted drug delivery, biological imaging and therapies (cancer therapy, etc).

### Text Books and References

1. T. Pradeep , “*NANO The Essential , understanding Nanoscience and Nanotechnology*”. Tata McGraw-Hill Publishing Company Limited, 2007.
2. Introduction to Nanotechnology, Chareles P.poole jr. and frank J.Owens, wiley inter science.
3. Nanotechnology Principles and Practices by Sulabha K. Kulakarni.
4. The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R. Rao, A. Muller and A.K. Cheetham
5. Introduction to Solid State Physics, C. Kittel, Wiley Eastern
6. Fundamentals of Nanoelectronics by George W. Hanson (Pearson Education,New delhi)
7. Nanotechnology and Nano Electronics – Materials, devices and measurement Techniques by W. R. Fahrner – Springer
8. NanoBiotechnology-BioInspired Devices and materials of the Future by Oded Shoseyov, Ilan Levy.
9. Bio Nano Technology by Good Sell, Wiley Liss
10. A practical approach to X-Ray diffraction analysis by C.Suryanarayana
11. Electron Microscopy and analysis by P.J. Goodhew and F.J. Humpreys
12. Scanning Electron Microscopy and X-ray microanalysis by J.I. Goldstein
13. Characterization of nanostructured materials by Z.L. Wang
14. Modern Raman Spectroscopy: A practical approach by E. Smith and G.Dent
15. Principles of Instrumental analysis by D.A. Skoog, F.J. Hollen and T.A. Niemann
16. Nanocomposite Science & Technology by P.M. Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co.

## **Physics (Weightage 50%) (Subject Specific)**

### **Unit 1**

Mechanics and Properties of Matter: - Frames of Reference, Rigid body dynamics , Moment of Inertia, Laws of Conservation. Gravitation, Elasticity, Viscosity, Surface Tension.

### **Unit 2**

Heat and Thermodynamics: – Kinetic Theory, Laws of Radiation, Thermodynamics, Liquefaction of Gases, Entropy, Heat engines and Refrigeration, Thermal Conductivity.

### **Unit 3**

Waves and Oscillations: – Progressive waves , Superposition , Doppler effect, Acoustics of Buildings, Fourier transforms, Ultrasonic.

### **Unit 4**

Optics: - Theories of Light, Interference, Diffraction, Polarisation, Optical Instruments , Resolving Power, Laser, Production, Properties and Applications, Holography, Optical Fibers.

### **Unit 5**

Electricity and Magnetism: – Electrostatics-magnetostatic, Alternating and Direct current, Thermoelectricity, Electromagnetism, Maxwell's equations..

### **Unit 6**

Atomic and Molecular Physics: – The electron, Atomic Models, Atomic spectra, Molecular spectra, Related measurements. Zeeman Effect, Raman effect, X-rays, Crystallography.

### **Unit 7**

Nuclear Physics: – Nuclear models , Properties of nucleus ,Nuclear reactions, Accelerator, Nuclear detectors Mass spectrograph ,Radioactivity, Cosmic ray, Mossbauer effect, Magnetic Resonance, Applications, Elementary Particles, Nuclear Energy.

### **Unit 8**

Solid State Physics: - Relativity, Special and General Theories of relativity,Statistical Physics, Specific Heats of Solids , Band Theory of solids, Classification of solids, Electrical and thermal properties, Dielectric and Magnetic Properties, Specific Heats of Solids, Superconductivity-

### **Unit 9**

Classical Mechanics and Quantum Physics: –constraints of motion, D'alembert's Principle, Lagrange's equation, Failure of Classical Physics, Duality, Wave function, Uncertainty Principle, Schrodinger wave equations and its applications, Eigen function and eigen values

### **Unit 10**

Semiconductors: - Electronics and Semiconductor devices-Digital Electronics-Transistors, Amplifiers, Logic Gates & Circuits.

### **Reference Books:**

1. Classical Mechanics by H. Goldstien (2<sup>nd</sup> Edition) (Addison-Wesley) 1980.
2. Concepts of Modern Physics by Arthur Beiser,(McGraw-Hill) 2002.
3. Elements of properties of matter by D S Mathur (S.Chand publication) 2010
4. Heat and Thermal Physics by Brijlal & Subramaiam (S.Chand Publication) 2014
5. Elements of Electronics by V.K.Mehta, (S. Chand and Co) 2013
6. A text book of Optics by by Subrahmaniyam N,Brij Lal and M N Avadhanalu,( S.Chamd) 2006.
7. Introduction to Atomic and Molecular Spectroscopy by V. K. Jain, Vimal Kumar Jain (Alpha Science International Limited) 2007.
8. Introductory Nuclear Physics by Kenneth Crane(Wiley Indai Pvt Ltd) 2008.
9. Engineering physics by R.K.Gaur and S.L. Gupta. Dhanpathrai Publications

## Polymer Science & Technology (Weightage 50%) (Subject Specific)

### Unit 1

**Chemistry of high polymers:** Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

### Unit 2

**Polymer Characterization:** Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

### Unit 3

**Synthesis and properties of thermoplastics:** Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, and Fluoropolymers

### Unit 4

**Synthesis and properties of thermosetting polymers:** PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

### Unit 5

**Polymer blends:** Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology,

### Unit 6

**Polymer composites:** Polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

### Unit 7

**Polymer Technology:** Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, cross-linking and vulcanization and vulcanization kinetics.

### Unit 8

**Polymer rheology:** Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. Visco-elasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

### Unit 9

**Polymer processing:** Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill and internal mixer.

### Unit 10

**Polymer testing:** Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress and cracking resistance.

## **Textile / Silk Technology (Weightage 50%) (Subject Specific)**

### **Unit 1**

**Textile Polymers:** Classification of polymers. Various Fibre forming polymers. Application of polymers. Study of various methods of polymerisation viz addition, chain, co-ordination polymerization. Study of various types of initiators. Techniques of polymerisation. Copolymerisation.

Nature of polymeric fluids. Flow of polymeric fluids, rheology of polymers – derivation of various laws to flow of polymeric fluids. Mechanical behavior of polymers- tensile behavior. Time dependent behaviour and temperature dependent mechanical behaviour.

Thermal analysis of polymers – glass transition temperature of polymers. Determination of glass transition temperature. Free volume concept. Time temperature Superposition in polymers. Study of thermal characterization by DSC, DTA and TGA.

### **Unit 2**

**Textile Fibres:** Basic requirements of textile fibers. cultivation & grading of cotton, wool, silk, & jute fibers. Brief study of physical & chemical properties of cotton, wool, silk & bast fibers. India's position of natural fibers in global scenario.

Regenerated fibers, chemistry and physics of viscose rayon production. Production of modified viscose rayon, brief outline on production of acetate & cuprammonium rayon. Manufacture of Tencel, 'Modal' 'lyocell', Bamboo and Basalt fibre.

Production of raw materials for synthetic fibres. Study of Production of PET by DMT & TPA routes. Study of Production of polyamides, effect of various parameters on nylon-6 Production study of semi-continuous & integrated continuous process for Production of nylon-6, Production of nylon-66. Study of Production of carbon, boron, silicon, carbide, alumina & glass fibres. Study of Production of aromatic polyamides viz. Nomex, Kevlar, technova. Concept of liquid crystal, thermo tropic & Lyotropic polymers & fibres. Study of Production of LDPE, HDPE, by GEL spinning technique. Production and properties of PBZT AND PBZO fibres. Study of moisture, mechanical, optical, Frictional, thermal and electrical properties of Textile fibers.

### **Unit 3**

#### **Yarn Manufacture-1**

**Blow Room:** Modern developments in blowroom machineries, evaluation of blowroom performance, calculation regarding blowroom line.

Need of blending, Process modification required in blowroom for processing various blends like Polyester/cotton, Polyester/viscose, silk and its blends. Types of blending operation and blending procedure.

Various quality control studies in blowroom like rejection percentage, cleaning efficiency within and between lap variations.

**Carding:** Study on working of revolving flat card, calculation of production, draft etc. incarding.

Modern developments in carding. Various quality control studies in carding.

**Drawing:** Operating principle of draw frame., roller drafting systems, behaviour of fibres of drafting zone. Friction field, distribution for drafting arrangement. Autolevelling in drawframe. Calculations pertaining to drawframe. Quality control studies in drawframe.

**Combing:** Hook theory. Preparatory process for combing. Types of comber. Sequence of operations in rectilinear comber, straightening of hooks, parameters influencing the combing operations. Detailed study of modern combing Calculations in comber, fractionating efficiency, quality control studies in combing.

## Unit 4

### Yarn Manufacture-2

**Speed Frame:** Operating sequence, drafting arrangements and systems. Design of spindle and flyer. Winding of bobbin – mechanism, package built bobbin drive, cone drive, lifter motion and builder motion, bobbin leading and flyer leading mechanism, Study modern speed frames. Quality control studies in speed frame, calculations pertaining to speed frame.

**Ring Frame:** Study of the ring frame mechanisms. Twist flow in Ring spinning. Latest developments in ring spinning. Production calculations Modifications required in ring frames to process various types of blends. Studies on ring and travelers and ring doublers.

**Open End Spinning:** Limitations of Ring spinning. Principles of O E Spinning. Rotor Spinning.

Study on Unconventional Spinning i.e. Dref Spinning, Airjet Spinning and Compact Spinning. **Texturising:** Study on different methods of texturising. False twist, draw texturing, airjet texturing, stuffer box crimping, knife edge crimping, knit-de-knit crimping.

## Unit 5

### Fabric Manufacture-1

**Winding:** Detailed study on warp and weft winding.

**Warping:** Different types of modern creels. Study of modern, friction driven and spindle driven beam warping machines. Study of different types of sectional warping machines and their salient features.

**Sizing:** Objects of sizing. Study of Ingredients used for size preparation. Size formulation, mixing vessels Techniques of sizing, Sizing of Natural, man-made fibres and their blends. Concept of single end sizing. Studies on various sizing machine.

**Shedding:** Detailed studies on shedding, picking, betup, secondary. Auxiliary and box motions.

**Automatic Looms:** Cop changing, shuttle changing looms, feelers, types of feelers, shuttle eye cutters, temple eye cutters and their settings.

## Unit 6

### Fabric Manufacture-2

**Dobby Looms:** Mechanical design and working principles of different types of dobbys

**Jacquard:** Mechanical design and operating principles of different types of jacquard.

**Shuttle-less looms:** Study of special features of rapier, projectile, water-jet, Air-jet looms.

## Unit 7

### Chemical Processing: 1

**Preparatory process to Dyeing/Printing:** Methods of singeing, Methods of desizing, Mechanism of scouring, methods of scouring, scouring of natural cellulose fabrics, degumming of silk, scouring of wool and jute, scouring of synthetic, Mechanism of bleaching, methods of bleaching, bleaching of various fibres.

**Mercerization:** Studies on mercerization Developments of mercerization, physical and chemical changes in cotton due to mercerization, various factors affecting mercerization, methods of mercerization – yarns and fabrics,

**Dyeing:** Chemicals Effect of fibre structure on dyeing behaviour. Theories of dyeing. Properties, Selection and application of various dyes like direct dyes, basic dyes, acid dyes, Sulphur dyes, Azoic dyes, Vat dyes, Sol-vat dyes, Mordant dyes, Reactive dyes, Disperse dyes, Modified basic dyes on important natural and manufactured fibres. Various after treatments given to dyed goods. Introduction to natural dyes and their methods of application. Factors affecting dyeing. Working principles of dyeing machinery for yarns, fabrics and garments.

## **Unit 8**

### **Chemical Processing: 2**

**Textile Printing:** - The constituents and characteristic of printing paste. Brief study of different binders, thickeners, solvents, discharging agents and other ingredients of printing paste. Styles of printing above styles. Methods of printing – Printing by Hand block, Roller, hand screen, semi-automatic screen, flat bed and rotary screen and transfer printing methods.

**Textile Finishing:** Classification of various finishes. Various finishing chemicals used and their properties. Calendering and various calendering machines used. Sanforization – principle and the process. Resin and anti-crease finish on cotton and protein fibre fabrics. Water repellent finishes, fire retardant and fire proof finishes. Finishing of woollen materials, silk fabrics and blended products. Finishing of synthetic fibre fabrics - heat setting, de-lustering, anti-static, soil release, etc.

## **Unit 9**

### **Silk Technology**

Status of sericulture and silk industry in India and abroad. Mulberry cultivation practices, Silk worm rearing, recent developments in rearing. Different types of cocoons, Physical and commercial characteristics, sorting and testing of cocoons. Stifling of cocoons, Merits & Demerits of silk reeling, systems of reeling, Recent developments in silk reeling. Manufacture of silk yarns for ordinary, Chiffon, Crape, Georgette fabrics. Recent developments in silk throwing machines. Silk weaving preparatory for warp & weft yarns, handloom fabrics.

## **Unit 10**

### **Textile Testing and quality control**

Sampling techniques. Moisture relation and testing. Fiber dimensions Viz., length, fineness, maturity and strength. Their technological importance and determination by various conventional and High Volume Instruments (HVI). FQI & its importance. Study of various systems of yarn count & its measurements by various methods & instruments.

Nep counting. Yarn twist & its effects on yarn & fabric properties. Principles & measurements of single & double yarn twist. Importance of twist multiplier. Yarn strength testing. Testing & grading of silk yarns. Principles of various evenness testers & measurement of evenness for sliver, roving & yarns. On-line quality control systems. Yarn friction & its measurements.

Determination of fabric length, width, thickness, weight. Thread density, crimp, air permeability. Thermal property, stiffness, handle, drape, shear, serviceability, wear, & abrasion resistance. Pilling, flammability, aesthetic properties. Fabric strength- tensile, tearing, bursting. Water & fabric relations & testing. Study of water penetration, shrinkage test, wetting of apparels & industrial fabrics. penetration of fabrics by water under pressure. Study of fabric cyclic properties like bending, shear, fatigue. Estimation of color fastness of dyed fabrics. Low stress mechanical and comfort properties of fabrics. Moisture management test. Statistical quality control studies. Assessment of fabric quality for garment industry - Testing & Inspection.