CIVIL ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector Identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's Integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.


Unit 2: Mechanics

Bending moment and shear force in statically determinate beams. Simple stress and strain relationship; Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

Unit 3: Structural Analysis

Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods, analysis by displacement methods (slope deflection and moment distribution methods), influence lines for
determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis.

Unit 4: Concrete Structures

Concrete Technology- properties of concrete, basics of mix design. Concrete design-basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of prestressed concrete, analysis of beam sections at transfer and service loads.

Unit 5: Steel Structures

Analysis and design of tension and compression members, beams and beam-columns, column bases. Connections-simple and eccentric, beam-column connections, plate girders and trusses. Plastic analysis of beams and frames.

Unit 6: Soil Mechanics

Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability and seepage, effective stress principle, consolidation, compaction, shear strength.

Unit 7: Foundation Engineering


Unit 8: Fluid Mechanics and Hydraulics:

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.


**Unit 9: Water requirements**

Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

**Unit 10: Highway Planning**

Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

Importance of surveying, principles and classifications, mapping concepts, coordinate system, map projections, measurements of distance and directions, leveling, theodolite traversing, plane table surveying, errors and adjustments, curves.
MECHANICAL ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.


Unit 2: Applied Mechanics and Design

Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, 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; strain energy methods; thermal stresses.

Unit 3: Theory of Machines and Vibrations

Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

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

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, spur gears, rolling and sliding contact bearings, brakes and clutches.

Unit 4: Fluid Mechanics

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli’s equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Unit 5: Heat-Transfer

Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Unit 6: Thermodynamics and Applications

Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle, irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

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

**Unit 7: Manufacturing Engineering**


Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

Joining: Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

**Unit 8: Machining and Machine Tool Operations**

Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.

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.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

**Unit 9: Production Planning and Control**

Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems.

**Unit 10: Operations Research:**
Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

ELECTRICAL AND ELECTRONICS ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrix Algebra, Systems of Linear equations, Eigen Values and eigen vectors.


Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.


Transform Theory: Fourier transform, Laplace transform, Z-transform.

Unit 2: Electric Circuits and Fields
Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin’s, Norton’s and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits.

Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere’s and Biot-Savart’s laws; inductance; dielectrics; capacitance.

Unit 3: Signals and Systems

Representation of continuous and discrete-time signals; shifting and scaling operations; linear, time-invariant and casual systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.

Unit 4: Electrical Machines

Single Phase transformer – equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers – connections, parallel operation; auto-transformer; energy conversion principles; DC machines – types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors – principles, types, performance characteristics, starting and speed control; Single phase induction motors; synchronous machines – performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

Unit 5: Power Systems

Basic power generation concepts; transmission line models and performance; cable performance insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis.

Unit 6: Protection and switchgear

Principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.
Unit 7: Control Systems

Principles of feedback; transfer function; block diagrams; steady state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.

Unit 8: Electrical and Electronic Measurements

Bridges and potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meters; Oscilloscopes; potentiometric recorders; error analysis.

Unit 9: Analog and Digital Electronics

Characteristics of diodes, BJT, FET; amplifiers biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multivibrators; sample and hold circuits; A/D and D/A convertors; 8-bit microprocessor basics, architecture, programming and interfacing.

Unit 10: Power Electronics and Drives

Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters fully controlled and half controlled; principles of choppers and inverters; basis concepts of adjustable speed dc and ac drives.
ELECTRONICS AND COMMUNICATION ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.


Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

**Unit 2: Networks**


**Unit 3: Electronic Devices**


**Unit 4: Analog Circuits**


**Unit 5: Digital Circuits**

Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs.
Semiconductor memories. Microprocessor (8085): architecture, programming, memory and I/O interfacing.

Unit 6: Signals and Systems


Unit 7: Control Systems

Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis; root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Unit 8: Analog Communication Systems

Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem.

Unit 9: Digital Communication Systems

pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.

Unit 10: Electromagnetics

Elements of vector calculus: divergence and curl; Gauss’s and Stokes’s theorems, Maxwell’s equations; differential and integral forms. Wave equation, Poynting vector.
Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines; characteristics impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

ELECTRONICS AND INSTRUMENTATION

Unit 1: Engineering Mathematics

Linear algebra- Matrix algebra-eigen values and eigen vectors; Calculus-evaluation of definite integrals, partial derivatives, maxima and minima, multiple integrals; Differential equations- first order (linear and non-linear), higher order linear differential equations with constant coefficients, Cauchy’s and Euler’s equations, initial and boundary value problems; partial differential equations-variable separable method; Complex variables-analytic functions, Cauchy’s integral theorem and integral formula, Taylor’s series, residue theorem; Numerical methods-solutions of non-linear algebraic equations and differential equations.

Unit 2: Electric Circuits

Ohm’s law, KCL, KVL, node and mesh analysis, ideal current and voltage sources, Network theorems: superposition, Thevenin’s, Norton’s, maximum power transfer; sinusoidal steady-state analysis; resonance; transient analysis of dc and ac networks; two-port networks; three-phase circuits.

Unit 3: Analog and Digital Circuits
Characteristics of diodes, BJTs, JFETs and MOSFETs; Amplifiers-single and multistage; Frequency response; Operational amplifiers - design, characteristics, linear and non-linear applications; instrumentation amplifiers; precision rectifiers; i\textit{i} to-V and V-to \textit{i} converters; active filters; comparators; signal generators and wave shaping circuits.

Combinational logic circuits-minimization of Boolean functions; IC families (TTL, MOS, CMOS); arithmetic circuits, multiplexer and decoders. Sequential circuits-flip-flops, counters, shift registers, schmitt trigger, timers, multivibrators and S/H circuits. Analog-to-digital and digital-to-analog converters. 8-bit and 16-bit microprocessors (architecture, memory and I/O interfacing) and 8-bit microcontroller.

Unit 4: Signals and Systems

Linear Time-Invariant (LTI) Systems - definitions and properties; causality, stability; Laplace transform and transfer function; Fourier series-Fourier transforms; Impulse and frequency responses of first and second order systems; Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; convolution and correlation; IIR and FIR filters.

Unit 5: Electrical and Electronic Measurements

Measurement of R, L and C; bridges and potentiometers; measurement of voltage, current, power, power factor and energy; instrument transformers; Q-meter; waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope; Noise and interference in instrumentation. Introduction to virtual instrumentation.

Unit 6: Transducers and Smart Instruments

Static and dynamic characteristics of transducers; units and standards; calibration techniques; classification of errors-error analysis; variable resistance, variable inductance and variable capacitance transducers; piezo-electric transducers; fibre-optic transducers; ultrasonic transducers; smart transducers; introduction to micro electro mechanical systems (MEMS).

Unit 7: Industrial and Analytical instrumentation

Pressure, flow, temperature and level measurements- principle of operation, installation and maintenance, calibration; measurement of force, torque, velocity, vibration, humidity, viscosity, and density.

Spectrophotometers (UV and IR); pH meters; conductivity meters; analyzers (O\textsubscript{2}, NO\textsubscript{2}, H\textsubscript{2}S), chromatography (gas and liquid); NMR spectroscopy, X-ray spectroscopy and mass spectrometer.
Unit 8: Control Systems

Principles of feedback; transfer function, signal flow graphs; time response analysis; Bode plots, root-loci, Routh and Nyquist criteria; compensation techniques; State space analysis.

Unit 9: Process control

Batch and continuous process; modeling-level, flow and thermal processes; servo and regulator operations; interacting and non-interacting systems; control actions (on-off, P, I, D, PI and PID) and controller tuning; complex control techniques (feed-forward, cascade, ratio and split-range); dynamic matrix control; distillation column control; control of heat exchanger; valve-types, characteristics, sizing, positioners, cavitation and flashing.

Unit 10: Logic and Distributed control system

PLC-sequential and programmable controllers, programming logic-ladder logic and function block programming; data acquisition system (DAS); direct digital control (DDC); supervisory control and data acquisition system (SCADA); distributed control system (DCS); HART and Field bus, OLE for process control (OPC)

COMPUTER SCIENCE AND ENGINEERING / INFORMATION TECHNOLOGY

Unit 1: Engineering Mathematics

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory and Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.


Calculus: Limit, Continuity & differentiability, Mean Value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

Unit 2: Theory of Computation

Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability; NP-completeness.

Unit 3: Digital Logic

Logic Functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

Unit 4: Computer Organization and Architecture

Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

Unit 5: Programming and Data Structures

Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

Unit 6: Algorithms

Analysis, Asymptotic notation, Notions of space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and-conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching.
Unit 7: Compiler Design

Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

Unit 8: Operating System

Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

Unit 9: Databases

ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

Unit 10: Computer Networks

ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP (v4), Application layer protocols (icmp, dns, smtp, pop,ftp, http); Basic concepts of hubs, switches, gateways, and routers.

PRODUCTION ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and Minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green’s theorems.

Differential equations: First order equations (linear and non-linear), Higher order linear differential equations with constant coefficients, Cauchy’s and Euler’s equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.
Complex variables: Analytic functions, Cauchy’s integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.


Unit 2: Engineering Materials and Applied Mechanics

Engineering Materials: Structure and properties of engineering materials and their applications: effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys, its influence on mechanical properties.


Unit 3: Theory of Machines and Design

Analysis of planar mechanisms, cams and followers; governors and fly wheels; design of elements ė failure theories; design of bolted, riveted and welded joints; design of shafts, keys, spur gears, belt drives, brakes and clutches.

Unit 4: Thermal Engineering

Fluid Mechanics ė fluid statics, Bernoulli’s equation, flow through pipes, equations of continuity and momentum; thermodynamics ė zeroth, first and second law of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; air standard cycles; basics of internal combustion engines and steam turbines; heat transfer ė fundamentals of conduction, convection and radiation, heat exchangers.

Unit 5: Metal Casting and Forming
Casting Processes ː types and applications; patterns ː types and materials; allowances; moulds and cores ː materials, making, and testing; casting techniques of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting inspection, defects and remedies.

Metal Forming ː Stress-strain relations in elastic and plastic deformation; concept of flow stress, deformation mechanisms; hot and cold working ː forging, rolling, extrusion, wire and tube drawing; sheet metal working processes such as blanking, piercing, blending, deep drawing, coining and embossing; analysis of rolling, forging, extrusion and wire/rod drawing; metal working defects.

Unit 6: Metal Joining Processes

Welding Processes ː manual metal arc, MIG, TIG, plasma arc, submerged arc, electroslag, thermit, resistance, forge, friction, and explosive Welding; other joining processes ː soldering, brazing, braze welding; inspection of welded joints, defects and remedies; introduction to advanced welding processes ː ultrasonic, electron beam, laser beam; thermal cutting.

Unit 7: Machining and Machine Tool Operations

Basic Machine tools; machining processes-turning, drilling, boring, milling, shaping, planning, gear cutting, thread production, broaching, grinding, lapping, honing, super finishing; mechanics of machining ː geometry of cutting tools, chip formation, cutting forces and power requirements, Merchant’s analysis; selection of machining parameters; tool materials, tool wear and tool life, economics of machining, thermal aspects of machining, cutting fluids, machinability; principles and applications of nontraditional machining processes ː USM, AJM, WJM, EDM and Wire cut EDM, LBM, EBM, PAM, CHM, ECM.

Tool Engineering: Jigs and fixtures ː principles, applications, and design; press tools ː configuration, design of die and punch; principles of forging die design.

Unit 8: Metrology and Inspection

Limits, fits, and tolerances, interchangeability, selective assembly; linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing of machine tools.

Unit 9: Powder Metallurgy

Production of metal powders, compaction and sintering.
Polymers and composites: Introduction to polymers and composites; plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Unit 10: Manufacturing Analysis

Sources of errors in manufacturing; process capability; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; manufacturing technologies – strategies and selection.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, cellular manufacturing, NC, CNC, DNC, Robotics, FMS and CIM.

METALLURGICAL ENGINEERING

Unit 1: Engineering Mathematics

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and Minima; Sequences and series; Test for convergence; Fourier series.
Vector Calculus: Gradient; Divergence and Curl; Line; Surface and Volume integrals; Stokes, Gauss and Green’s theorems.

Differential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy’s and Euler’s equations; Laplace transforms; PDEs i.e. Laplace; heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.


Unit 2: Thermodynamics and Rate Processes

Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams; thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps.

Unit 3: Electro Chemistry and Mass Transfer

Principles of electro chemistry i.e. single electrode potential, electro-chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high temperature corrosion i.e. characterization and control; heat transfer i.e. conduction, convection and heat transfer coefficient relations, radiation, mass transfer i.e. diffusion and Fick’s laws, mass transfer coefficients; momentum transfer i.e. concepts of viscosity, shell balances, Bernoulli’s equation, friction factors.

Unit 4: Extractive Metallurgy

Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro- and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals i.e. aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals.

Unit 5: Iron and Steel making
Principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

Unit 6: Physical Metallurgy

Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminium alloys; surface treatments; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; industrial ceramics, polymers and composites; electronic basis of thermal, optical, electrical and magnetic properties of materials; electronic and opto-electronic materials.

Unit 7: Mechanical Metallurgy

Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; super-plasticity; fracture Griffith theory, basic concepts of linear elastic and elasto-plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

Unit 8: Metal casting and Forming

Metal casting - Patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming - fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming;

Unit 9: Metal joining
Soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints;

**Unit 10: Powder Metallurgy**

NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.
Probability and statistics  Sampling theorem  Mean, Mode, Median and standard deviation  Random variables  Poisson, normal and binomial distributions  Correlation and regression analysis  Tests of significance ($x^2$ and $t$)


Unit 2: Microbiology and Cell Biology

Types of Microbes  Bacteria, fungi, algae and viruses  Staining of bacteria  Applications of microscopes

Growth Kinetics  Role of substrate  Growth phases  Monod Kinetics  Sterilization methods

Impact of microbes  Human diseases and welfare  Applications in agriculture  Bio and geo cycles

Cell and tissue structures  Cellular components and functions  Cell division / mitosis and meiosis  Cellular locomotion  Cytoskeletons

Membranes and transport  Cellular membrane structure  Transport of Na, K, Ca ions  Proton pump  Facilitated transports

Signals and Communications  Nervous Systems (signal transmission)  Endocrine systems (ligands, receptors and hormones)  Secondary signaling molecules (G proteins, etc.)

Unit 3: Biochemistry and Instrumental Methods

Biomolecules  Carbohydrates  Proteins  Lipids  Coenzymes and Cofactors

Biopolymer synthesis  DNA, RNA synthesis  Proteins synthesis  Lipid synthesis

Metabolic Pathways  Oxidative phosphorylation  Calvin cycle  Nucleic acid metabolism

Spectroscopic Methods  UV-Vis spectroscopy  IR, GC, HPLC  Mass Spec, XRD  Atomic Absorption, Fluorescence

Immunochemical methods  ELISA, RIA  Electrophoresis  Western Blot  Histochemical techniques
Chromatographic techniques – TLC, ion-exchange \( \rightarrow \) Gel permeation \( \rightarrow \) Immuno chromatography

Unit 4: Molecular Biology and Genetic Engineering

DNA and its modifications – DNA extraction, modifying enzymes \( \rightarrow \) DNA protein interaction \( \rightarrow \) Polymerase Chain Reaction

Molecular biological techniques – In vitro transcription \( \rightarrow \) In vitro translation \( \rightarrow \) Immuno precipitation

Recombinant DNA Technology – Expression systems \( \rightarrow \) Organismic modifications \( \rightarrow \) Fundamentals of Genetics \( \rightarrow \) Inheritance, selection \( \rightarrow \) Mendelism \( \rightarrow \) Genotype \( \rightarrow \) phenotype correlation \( \rightarrow \) One gene one enzyme hypothesis \( \rightarrow \) Epistasis

Gene mapping – Gene cloning \( \rightarrow \) Sequencing \( \rightarrow \) Complex diseases

Applications of genetics – Pharmacogenetics \( \rightarrow \) Prenatal diagnosis \( \rightarrow \) Hybrid vigour \( \rightarrow \) Gene Therapy

Unit 5: Enzyme and Immuno Technology

Sources and applications of free enzymes – Microbial, plant and animal enzymes \( \rightarrow \) Tanning, food and detergent industries \( \rightarrow \) Diagnostic applications

Enzyme Immobilization – Immobilization methods and supports \( \rightarrow \) Properties of free and immobilized enzymes \( \rightarrow \) Applications of immobilized enzymes

Purification and characterization – Extraction methods \( \rightarrow \) Purification techniques \( \rightarrow \) Enzyme characterization \( \rightarrow \) Development of enzyme assays

Principles of immunology – Antigen-antibody interaction \( \rightarrow \) Cell mediated immunoresponse \( \rightarrow \) Mechanism of antibody response

Immunodiagnostic techniques – In vitro methods \( \rightarrow \) In vivo methods

Vaccines – Immunological preparations \( \rightarrow \) Types of vaccines

Unit 6: Bioinformatics and Computational Biology

Introduction – Biological database: Genbank, Swissprot \( \rightarrow \) Human genome project \( \rightarrow \) DNA, RNA, protein sequences

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Pattern matching and Machine learning - Pairwise alignment, Multiple sequence alignment, BLAST, FASTA, Hidden Markov Models

Phylogeny - Irrelevant mutations and controls, Mutations as measure of time and distance, Time intervals and distances between species

Protein architecture - Primary structure, automated Edman method, Secondary structure, Tertiary structure

Protein folding - Scaffold design, Backbone loop and turn design, Search algorithms for domain analysis

Drug design - Computer aided drug design, Combinatorial chemistry, Protein, RNA structure prediction

Unit 7: Mass & Heat Transfer

Mass transfer fundamentals - Laws of diffusion, Vapour liquid equilibria, Liquid liquid equilibria, Adsorption equilibria

Distillation - Simple, steam, flash distillation, McCabe-Thiele Method, HETP, HTU, NTU concepts

Separation equipment - Rotary vacuum drier, Absorption tower, Staged and continuous extractor, Membrane separator

Heat transfer theory - Steady state conduction, Forced and natural convection, Combined conduction and convection, Extended surfaces

Design of heat transfer equipment - Double pipe heat exchanger, Shell and tube heat exchanger, Multiple effect evaporators

Operations - Cooling towers, Flash evaporation, Settling and sedimentation, Continuous filtration

Unit 8: Unit Operations & Biochemical Engineering

Stoichiometry and energetics of microbial metabolism - Mass and energy balance, Heats of reaction and vaporization, Energetics, ATP as energy currency, Enzyme catalysis - Enzyme catalyzed reactions, Inhibition, denaturation and deactivation, Enzyme kinetics, Mechanical, Menton
Upstream processing → Substrate preparation → Innoculum preparation → Sterilization techniques

Bioprocess parameters → Oxygen transfer in bioreactors → Bioprocess monitoring and control → Facultative and anaerobic fermentations

Downstream processing → Precipitation, centrifugation, ultra filtration → Crystallization and electrophoresis → Solvent mediated separations

Product recovery → Nutsche and rotary vacuum filters → Magma crystallizer → Supercritical extractor

Unit 9: Reaction Engineering & Thermodynamics

Chemical Kinetics → Rate equations for homogeneous reactions → Concentration and temperature dependence → Rate equations for heterogeneous catalytic reactions

Ideal reactors and non-ideal flow → Isothermal, batch reactors and flow reactors → Performance equations for single reactors RTD in non-ideal flow Reactor performance with non-ideal flow

Industrial reactors → Trickle bed reactors → Slurry reactors → Fluidized bed reactors

Solution thermodynamics → Concepts of chemical potential and fugacity → Ideal and non-ideal solutions → Activity coefficients → Gibbs-Duhem equation

Phase equilibrium → Criteria for phase equilibrium → Vapour-liquid equilibrium calculations for binary systems

Chemical reaction equilibria → Evaluation of equilibrium constant → Effect of T & P on equilibrium constant → Equilibrium conversion for single reactions

Unit 10: Applications of Biotechnology

Food Biotechnology → Food processing using bacteria, yeast, fungi → Single cell protein → Food preservation, cheese manufacture

Plant Biotechnology → Plant tissue culture → Vectors for plant modification → Genetically modified crops

Animal Biotechnology → Animal tissue culture → Products from animal cell culture → Transgenic animals
Chemical feedstock and acids – Ethanol, butanol, acetone, glycerol ï Citric, lactic, acetic acids ï Glutamic, aspartic acids and phenylalanine

Environmental Biotechnology – Aerobic and anaerobic treatment of waste water - Solid waste treatment ï Air pollution and control

Antibiotics and Enzymes – Penicillin, streptomycin, erythromycin ï Proteases, amylases, lipases ï Biopesticides, biofertilizers

ENGLISH

Unit 1: Chaucer to Shakespeare

Geoffrey Chaucer : The Prologue to the Canterbury Tales
Edmund Spenser : Prothalamion
Shakespeare : Sonnets
SYLLABUS FOR COMPETITIVE EXAMINATION FOR RECRUITMENT OF ASSISTANT PROFESSORS IN GOVERNMENT ENGINEERING COLLEGES

(12,18,29,30,33,53,54,60,65,73,90,94,107,116,144)

John Donne : A Valediction : Forbidding Mourning
Andrew Marvell : To His Coy Mistress
Francis Bacon : Of Truth
Of Death
Of Revenge
Of Marriage and Single Life
Of Ambition
Of Nobility
Christopher Marlowe : Dr. Faustus
Thomas Middleton : The Changeling
John Webster : The Duchess of Malfi
William Shakespeare : Twelfth Night
Henry IV Part I
Macbeth
The Tempest
Antony and Cleopatra

Unit 2 : Jacobean to Augustan Age

John Milton : Paradise Lost i Book IX
John Dryden : Mac Flecknoe
Alexander Pope : An Epistle to Dr. Arbuthnot
Thomas Gray : Elegy Written in a Country Churchyard
Thompson : Spring
Autumn
Winter
William Collins : Ode to Evening
William Blake : A Poison Tree
The Tiger
The Lamb
John Dryden : Preface to the Fables
Jonathan Swift : The Battle of the Books
Daniel Defoe : Robinson Crusoe
Addison and Steele : The Spectator and the Coverly Papers (Essays 1-10 Macmillan Edn.)
Samuel Johnson : Preface to Shakespeare
William Congreve : The Way of the World
R.B. Sheridan : The Rivals
Goldsmith : She Stoops to Conquer
Henry Fielding : Tom Jones

Unit 3 : Romantic Period

Wordsworth : Intimation Ode
Tintern Abbey
Coleridge : Kubla Khan
The Rime of the Ancient Mariner
## SYLLABUS FOR COMPETITIVE EXAMINATION FOR RECRUITMENT OF ASSISTANT PROFESSORS IN GOVERNMENT ENGINEERING COLLEGES 2011

<table>
<thead>
<tr>
<th>Authors</th>
<th>Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.B. Shelley</td>
<td>To a Skylark</td>
</tr>
<tr>
<td>John Keats</td>
<td>Ode to a Nightingale</td>
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<tr>
<td></td>
<td>Ode on a Grecian Urn</td>
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<tr>
<td>Byron</td>
<td>Vision of Judgement</td>
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<tr>
<td>Charles Lamb</td>
<td>Essays of Elia</td>
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<tr>
<td></td>
<td>1. The South-Sea House</td>
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<td></td>
<td>2. Dream Children : A Reverie</td>
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<td></td>
<td>3. Christ Hospital Five and Thirty Years Ago</td>
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<td></td>
<td>4. Oxford in the Vacation</td>
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<td></td>
<td>5. All Fools' Day</td>
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<tr>
<td>Wordsworth</td>
<td>Preface to the Lyrical Ballads</td>
</tr>
<tr>
<td>Walter Scott</td>
<td>The Heart of Midlothian</td>
</tr>
<tr>
<td>Jane Austen</td>
<td>Pride and Prejudice</td>
</tr>
<tr>
<td>Emily Bronte</td>
<td>Wuthering Heights</td>
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</tbody>
</table>

### Unit 4: Romantic Period

<table>
<thead>
<tr>
<th>Authors</th>
<th>Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennyson</td>
<td>Ulysses</td>
</tr>
<tr>
<td>Robert Browning</td>
<td>My Last Duchess</td>
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<tr>
<td>Matthew Arnold</td>
<td>The Scholar Gipsy</td>
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<td></td>
<td>Dover Beach</td>
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<tr>
<td>D.G. Rossetti</td>
<td>The Blessed Damozel</td>
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<tr>
<td>G.M. Hopkins</td>
<td>The Wreck of the Deutschland</td>
</tr>
<tr>
<td>Matthew Arnold</td>
<td>The Study of Poetry</td>
</tr>
<tr>
<td>Oscar Wilde</td>
<td>The Importance of Being Earnest</td>
</tr>
<tr>
<td>Charles Dickens</td>
<td>Great Expectations</td>
</tr>
<tr>
<td>Thomas Hardy</td>
<td>The Woodlanders</td>
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</tbody>
</table>

### Unit 5: Modern and Contemporary Periods

<table>
<thead>
<tr>
<th>Authors</th>
<th>Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.B. Yeats</td>
<td>Sailing to Byzantium</td>
</tr>
<tr>
<td>T.S. Eliot</td>
<td>The Waste Land</td>
</tr>
<tr>
<td>W.H. Auden</td>
<td>The Unknown Citizen</td>
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<tr>
<td>Philip Larkin</td>
<td>Church Going</td>
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</tbody>
</table>

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## SYLLABUS FOR COMPETITIVE EXAMINATION FOR RECRUITMENT OF ASSISTANT PROFESSORS IN GOVERNMENT ENGINEERING COLLEGES 2011

<table>
<thead>
<tr>
<th>Author</th>
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</tr>
</thead>
<tbody>
<tr>
<td>C.B. Lewis</td>
<td>Fern Hill</td>
</tr>
<tr>
<td>T.S. Eliot</td>
<td>Tradition and the Individual Talent</td>
</tr>
<tr>
<td>E.M. Forster</td>
<td>(Selections from E.M. Forster. Edited by R. Krishnamoorthi &amp; Published by Macmillan).</td>
</tr>
<tr>
<td></td>
<td>1. Notes on the English Character</td>
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<tr>
<td></td>
<td>2. My Wood</td>
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<td>3. Hymn Before Action</td>
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<td>4. Tolerance</td>
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<td>5. What I Believe</td>
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<tr>
<td>G.B. Shaw</td>
<td>Arms and the Man</td>
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<tr>
<td>John Osborn</td>
<td>Look Back in Anger</td>
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<tr>
<td>T.S. Eliot</td>
<td>Murder in the Cathedral</td>
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<tr>
<td>D.H. Lawrence</td>
<td>The Rainbow</td>
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<tr>
<td>William Golding</td>
<td>Lord of the Flies</td>
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<tr>
<td>Joseph Conrad</td>
<td>Lord Jim</td>
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</table>

### Unit 6: American Literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerson</td>
<td>Brahma</td>
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<tr>
<td>Poe</td>
<td>The Raven</td>
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<tr>
<td>Whitman</td>
<td>When Lilacs Last in the Dooryard Bloomd</td>
</tr>
<tr>
<td>Emily Dickinson</td>
<td>Success is Counted Sweetest</td>
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<tr>
<td></td>
<td>I Tasted a Liquor Never Brewed</td>
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<td></td>
<td>Because I Could not Stop for Death</td>
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<td></td>
<td>A Narrow Fellow in the Grass</td>
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<tr>
<td>Robert Frost</td>
<td>Mending Wall Stopping By Woods on a Snowy Evening</td>
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<tr>
<td>Wallace Stevens</td>
<td>The Emperor of Ice-cream</td>
</tr>
<tr>
<td>Emerson</td>
<td>The American Scholar</td>
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<tr>
<td>Henry James</td>
<td>The Art of Fiction</td>
</tr>
<tr>
<td>O'Neill</td>
<td>The Hairy Ape</td>
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<tr>
<td>Edward Albee</td>
<td>Who's Afraid of Virginia Woolfe</td>
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<tr>
<td>Hawthorne</td>
<td>The Scarlet Letter</td>
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<tr>
<td>Mark Twain</td>
<td>Huckleberry Finn</td>
</tr>
<tr>
<td>Ernest Hemingway</td>
<td>The Old Man and the Sea</td>
</tr>
<tr>
<td>Faulkner</td>
<td>The Sound and the Fury</td>
</tr>
<tr>
<td>Alice Walker</td>
<td>Color Purple</td>
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</tbody>
</table>

### Unit 7: Indian and English Literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>Toru Dutt</td>
<td>The Lotus</td>
</tr>
<tr>
<td></td>
<td>Our Casuarina Tree</td>
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<tr>
<td>R. Parthasarathy</td>
<td>Under Another Sky</td>
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<td></td>
<td>A River Once</td>
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<tr>
<td>Sarojini Naidu</td>
<td>Indian Weavers</td>
</tr>
</tbody>
</table>
SYLLABUS FOR COMPETITIVE EXAMINATION FOR RECRUITMENT OF ASSISTANT PROFESSORS IN GOVERNMENT ENGINEERING COLLEGES 2011

Kamala Dass : Introduction My Grandmother’s House
Nissim Ezekiel : Enterprise
Night of the Scorpion
A.K.Ramanujan : Small Scale Reflections on a Great House
Obituary
Sri Aurobindho : The Renaissance in India
Tagore : Post Office
Girish Kamard : Tughlaq
Chaman Nahal : Azadi
Deshpande : The Dark Holds No Terror
Arundathi Roy : God of Small Things

Unit 8 : Language and Linguistics

Family of Indo-European Languages
Foreign Influences
Word Making
Change of Meaning
Spelling Reforms
Standard English
Morphology
Basic Sentence Patterns
IC Analysis
Structural Linguistics
T.G. Grammar
English Language Teaching
Translation
Semantics, Pragmatics and Discourse
Descriptions and classification of Consonants and Vowels
Accent
Intonation
Phonetic Transcription
Writing a research paper: Bibliography, abstract, documentation, etc.,
Mechanics of thesis writing

Unit 9 : Criticism and Literary Theories

Aristotle : Poetics
Dr.Johnson : Life of Milton
T.S.Eliot : The Function of Criticism
I.A.Richards : Four Types of Meaning
Northrop Frye : The Archetypes of Literature
Lionel Trillin : The Meaning of a Literary Idea
Rolland Barthes : The Death of the Author
Wayne Booth : Telling and Showing
Edward Wilson : A Historical Interpretation of Literature
Derrida : Structure, Sign and Play in the Discourse of Human Sciences
Terry Eagleton : Capitalism, Modernism and Post Modernism
Elaine Showalter : Towards a Feminist Poetics
Gayatri Spivak : Imperialism and Sexual Difference

Unit 10: Post Colonial Literature and European Literature in Translation

A.G. Smith : Ode on the Death of William Butler Yeats
Margaret at Wood : Journey to the Interior
P.K. Page : Adolescence
Wilfered Campbell : The Winter Lakes
George Ryga : The Ecstasy of Rita Joe
Margaret Lawrance : The Stone Angel
Ondaatje : Running in the Family
Sir Thomas More : Utopia
Moliere : The Misanthropist
Ibsen : A Doll's House
Wole Soyinka : The Lion and the Jewel
Chinua Achebe : Things Fall Apart
MATHEMATICS

Unit 1: Real Analysis

Finite-countable and uncountable sets, Bounded and unbounded sets, Archimedean Property, Ordered field, Completeness of $\mathbb{R}$, Extended real number system, Sequences and series, Limit supremum and limit infimum of a sequence, Convergence of sequences and series, Uniform convergence, Continuity of a function, Types of discontinuities, Uniform continuity, Differentiability, Rolle's theorem, Mean value theorem, Monotone functions, Functions of bounded variations, Riemann Integral and its properties, Improper integrals and their convergence and uniform convergence, Sequence of functions and series of functions, Pointwise convergence and uniform convergence, Bolzano-Weierstrass Theorem, Compact subsets of $\mathbb{R}^n$, Heine-Borel Theorem, Riemann-Stieltjes integral and its properties, Partial, directional and total derivatives in $\mathbb{R}^n$.

Unit 2: Complex Analysis


3. Algebra

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, Permutation groups, symmetric groups, alternating groups, simple groups, Sylow's theorem, Finite abelian groups, Rings, ideals, integral domains, polynomial rings, Euclidean ring, Principal ideal domains, Unique factorisation domains, Finite fields, Extension fields, Splitting fields, Galois Theorem.

4. Topology

Topological spaces-Basis for a topology-The product topology į The subspace topology-Closed sets and limit points, Continuous functions-the product topology- The metric topology. Connected spaces-connected subspaces of the Real line į Components and local connectedness, Compact spaces-compact subspaces of the Real line į Limit Point Compactness į Local Compactness. The Countability Axioms į The separation Axioms į Normal spaces į The Urysohn Lemma į The Tietze extension theorem.

5. Measure Theory and Functional Analysis


**Functional Analysis:** Normed Linear space-Continuous Linear Transformations į Banach spaces-The Hahn-Banach Theorem į The natural embedding of N in $N^{**}$ - Open mapping theorem į Closed graph Theorem į Uniform boundedness theorem į conjugate of an operator į Inner product space į Orthogonalisation process į Hilbert Space į Orthonormal sets-Orthogonal complements į conjugate space $H^*$ - Adjoint of an operator į Self-adjoint į Normal and Unitary Operators į Projections.

6. Differential Equations

**Ordinary Differential Equations:** Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two. Homogeneous and non-homogeneous equation of order n į Initial value problems- Annihilator method to solve non-homogeneous equation- Algebra of constant coefficient operators. Initial value problems į Existence and uniqueness theorems- Solutions to solve a non-homogeneous equation į Wronskian and linear dependence į reduction of the order of a homogeneous equation - homogeneous equation with analytic coefficients į The Legendre equation. Euler equation į Second order equations with regular singular points į Exceptional cases į Bessel Function. Equation with variable separated į Exact equation- method of successive approximations į the Lipschitz condition-convergence of the successive approximations and the existence theorem.

7. Mechanics and Numerical Methods


8. Probability and Mathematical Statistics

Central limit theorem (Lindberg Theorem and Lapunov Theorem) Borel-Cantelli Lemma ï Kolmogorov Strong Law of large numbers.

**Mathematical Statistics:** Sampling: Sample mean, sample variance and their independence-Moments of sample mean and sample variance, t distribution, F distribution. Point Estimation: Unbiasedness, consistency, sufficiency, efficient and asymptotically most efficient-Method of moments: One parameter and two parameters cases-Maximum likelihood Estimation: One parameter and two parameter cases unbiasedness, mean square error, CR bound. Interval Estimation: Derivation of confidence interval:-The pivotal method, confidence limits, sample size, confidence interval for the normal distribution (mean, variance)-Confidence interval for Binomial and Poisson-Confidence interval for two sample problems (Two normal means, two population variances, two population propositions, two Poisson parameters, paired data). Hypotheses, test statistics, decision and errors: Hypotheses (Null, alternative, simple and composite), one sided and two sided tests, test statistics, errors (Type I and II errors), Best Test (smallest type-II error), p ï values. Best Tests: Testing the value of a population mean, of population variance, of population proposition. Of the mean of Poisson. Best Tests: Testing the value of the difference between two population means, ratio of two population variances, difference between population propositions, difference between two Poisson means, paired data. Tests and confidence intervals: chi-square test, goodness of fit, contingency table for independence. ANOVA: One way and two way classifications.

9. **Differential Geometry and Graph Theory**

Space curve - Arc length ï tangent ï normal and binormal ï curvature and torsion ï contact between curves and surfaces- tangent surface ï involutes and evolutes- Intrinsic equations ï Fundamental Existence Theorem for space curves-Helics. Surface ï curves on a surface ï Surface of revolution ï Helicoids ï Metric ï Direction coefficients ï families of curves-Isometric correspondence- Intrinsic properties. Geodesics ï Canonical geodesic equations ï Normal property of geodesics- Existence Theorems ï Geodesic parallels ï Geodesics curvatures ï Gauss-Bonnet Theorem ï Gaussian curvature-surface of constant curvature. The second fundamental form-Principle curvature ï Lines of curvature ï Developable ï Developable associated with space curves and with curves on surface ï Minimal surfaces ï Ruled surfaces. Compact surfaces whose points are umblics-Hilbertâ lemma ï Compact surface of constant curvature ï Complete surface and their characterization ï Hilbertâ Theorem ï Conjugate points on geodesics.

**Graph Theory:** Graphs and simple graphs ï Graphs Isomorphism ï The Incidence and Adjacency Matrices ï Subgraphs ï Vertex Degrees ï Paths and Connections ï Cycles ï Trees ï Cut Edges and Bonds ï Cut Vertices. Connectivity - Blocks ï Euler tours- Hamilton Cycles. Matchings ï Matchings and Coverings in Bipartite

10. Mathematical Programming and Fluid Dynamics


PHYSICS

Unit 1: Mathematical Methods


Unit 2: Classical Mechanics and Relativity


Unit 3: Quantum Theory and its Applications

Unit 4: Electromagnetic Theory


Unit 5: Thermodynamics and Statistical Mechanics

Laws of thermodynamics and their consequences, Thermodynamic potentials and Maxwell's relations, Chemical potential and phase equilibria, Phase space, microstates and macrostates, Partition function, Free energy and its connection with thermodynamic quantities, Classical and quantum statistics, Degenerate electron gas, Black body radiation and Planck's distribution law, Bose-Einstein condensation, Einstein and Debye models for lattice specific heat.

Unit 6: Atomic and Molecular Physics


Unit 7: Condensed Matter Physics

Crystal classes and systems, 2d and 3d lattices, Bonding in common crystal structures, Reciprocal lattice, Diffraction and structure factor, Elementary ideas about point defects and dislocations, Lattice vibrations, Phonons, Specific heat of solids, Free electron theory, Fermi statistics, Heat capacity, Electron motion in periodic potential, Energy bands in metals, insulators and semiconductors, Tight binding approximation, Impurity level in doped semiconductors, Electronic transport from classical kinetic theory, Electrical and thermal conductivities, Hall effect and thermoelectric power, transport in semiconductors, Dielectrics.
Polarization mechanism \(\rightarrow\) Clausius- Mossotti equation \(\rightarrow\) Piezo, pyro and ferroelectricity \(\rightarrow\) Dia and paramagnetism \(\rightarrow\) Exchange interactions \(\rightarrow\) Magnetic ordering : ferro, antiferro and ferrimagnetism \(\rightarrow\) Superconductivity: Basic phenomenology \(\rightarrow\) Meissner effect \(\rightarrow\) Type 1 and Type 2 superconductors \(\rightarrow\) BCS pairing mechanism.

**Unit 8 : Nuclear and Particle Physics**

Basic nuclear properties \(\rightarrow\) Size, shape, charge distribution, spin and parity \(\rightarrow\) binding energy \(\rightarrow\) empirical mass formula - liquid drop model \(\rightarrow\) Nuclear forces - Elements of two \(\rightarrow\) body problem \(\rightarrow\) Charge independence and charge symmetry of nuclear forces - Evidence of nuclear shell structure \(\rightarrow\) Single particle shell model \(\rightarrow\) Its validity and limitations \(\rightarrow\) Collective model \(\rightarrow\) Interactions of charged particles and e.m.rays with matter \(\rightarrow\) Basic principles of particle detectors \(\rightarrow\) Ionization chamber \(\rightarrow\) Proportional counter \(\rightarrow\) GM counter \(\rightarrow\) Scintillation and semiconductor detectors \(\rightarrow\) Radioactive decays: Basic theoretical understanding \(\rightarrow\) Nuclear reactions \(\rightarrow\) Elementary ideas of reaction mechanism \(\rightarrow\) Compound nucleus and direct reactions \(\rightarrow\) Elementary ideas of fission and fusion \(\rightarrow\) Particle Physics: Symmetries and Conservation laws \(\rightarrow\) Classification of fundamental forces and elementary particles \(\rightarrow\) Iso-spin \(\rightarrow\) Strangeness - Gell-Mann Nishijima formula \(\rightarrow\) Quark model \(\rightarrow\) C.P.T.invariance in different interactions \(\rightarrow\) Parity nonconservation in weak interaction.

**Unit 9: Electronics**

Physics of p-n junction \(\rightarrow\) Diode as a circuit element \(\rightarrow\) Clipping \(\rightarrow\) Clamping \(\rightarrow\) Rectification \(\rightarrow\) Zener regulated power supply \(\rightarrow\) Transistor as a circuit element - CC, CB and CE configuration \(\rightarrow\) Transistor as a switch, OR, AND, NOT gates \(\rightarrow\) Feedback amplifiers \(\rightarrow\) Operational amplifiers and its applications \(\rightarrow\) Inverting, non-inverting amplifier \(\rightarrow\) Adder \(\rightarrow\) Subtractor \(\rightarrow\) Integrator \(\rightarrow\) Differentiator \(\rightarrow\) Waveform generator \(\rightarrow\) Comparator \(\rightarrow\) Schmidt trigger \(\rightarrow\) Digital integrated circuits \(\rightarrow\) NAND and NOR gates as building blocks \(\rightarrow\) X- OR gate \(\rightarrow\) Simple combinational circuits \(\rightarrow\) Half and full adder \(\rightarrow\) Flip-flop \(\rightarrow\) Shift register \(\rightarrow\) Counters \(\rightarrow\) Basic principles of A/D and D/A converters- Simple applications of A/D and D/A converters \(\rightarrow\) Microprocessor 8085: Architecture \(\rightarrow\) Addressing modes \(\rightarrow\) Instruction sets \(\rightarrow\) Simple programming.

**Unit 10 : Experimental Physics**

Measurement of fundamental constants: e, h, c \(\rightarrow\) Measurement of high and low resistances, L and C \(\rightarrow\) Detection of X-rays, gamma rays, charged, particles, neutrons etc \(\rightarrow\) ionization chamber \(\rightarrow\) proportional counter \(\rightarrow\) GM counter \(\rightarrow\) Scintillation detectors \(\rightarrow\) Solid state detectors \(\rightarrow\) Emission and absorption spectroscopy \(\rightarrow\) Measurement of magnetic field. Hall effect \(\rightarrow\) Magnetoresistance \(\rightarrow\) X-ray and neutron diffraction \(\rightarrow\) Vacuum techniques \(\rightarrow\) Basic idea of conductance \(\rightarrow\) Pumping speed etc - Pumps: Mechanical pump \(\rightarrow\) Diffusion pump \(\rightarrow\) Gauges: Thermocouple \(\rightarrow\) Penning \(\rightarrow\) Pirani \(\rightarrow\) Hot cathode \(\rightarrow\) Low temperature: cooling a
sample over a range upto 4 K and measurement of temperature ĭ Error analysis and hypothesis testing ĭ Propagation of errors ĭ Plotting of graph - Distributions ĭ Least squares fitting - Criteria for goodness of fits ĭ Chi square test.

**CHEMISTRY**

Unit -1

**Analytical Chemistry:** Classification of analytical Methods ĭ classical and instrumental. Errors and Evaluation: Definition of terms in mean and median ĭ Types of errors, propagation of errors, accuracy and precision, least squares analysis, average standard deviation.

**Analytical Techniques:** Principle and applications of adsorption, partition, ion exchange and solvent extraction chromatographic methods ĭ TLC HPLC and GC. Applications of atomic, molecular and emission spectroscopy in quantitative analysis Electroanalytical techniques ĭ cyclic and stripping voltametry, polarography, TGA, DTA, and DSC. Light scattering techniques including nepelometry and Raman spectroscopy.

Unit-2

**Structure and Bonding:** Atomic orbitals ĭ Types of chemical Bonds (weak and strong) intermolecular forces ĭ Theories of bonding (VB and MO) ĭ Concept of hybridization ĭ shapes of polyatomic molecules ĭ VSEPR theory ĭ Structure of simple ionic and covalent compounds ĭ lattice energy ĭ crystal defects ĭ Insulators and semiconductors, superconductors, Band theory of solids ĭ Solid state reactions.

**Acids and Bases:** Bronsted and Lewis acids and bases, pH and pKa, acid-base concept in nonaqueous media, HSAB concept, Buffer solution.

**Redox Reactions:** Oxidation numbers, Redox potential, electrochemical series, Redox indicators, Chemical principles involved in extractions and purification of Iron, Copper, Lead, Zinc and Aluminium.

Unit-3

**Nuclear Chemistry:** Radioactive decay and equilibrium, Nuclear reactions: Q valve, cross sections, types of reactions, Nuclear transmutations, fission and fusion Radioactive techniques-tracer technique, neutron activation analysis. G.M, Ionization and proportional counters. Radiolysis of water ĭ G value, dosimeters and Hydrated electron.

**Chemistry of Non-transition elements:** General properties and structure of their halides and oxides. Polymorphism of carbon, phosphorus and sulphur. Synthesis,
properties and structure of boranes, carboranes and metallo carboranes - Wade’s rule - preparation, properties and structure of borazines & phosphazenes.

Sulphur-nitrogen compounds-Oxides and oxyacids of nitrogen, phosphorous, sulphur and halogens. Interhalogen and noble gas compounds. Isopoly and heteropoly acids and salts.

Unit-4

Chemistry of Transition elements: Co-ordination Chemistry of transition metal ions-Werner’s theory - nomenclature and stereo chemistry of co-ordination compounds - stability constants and their determinations - CFT, splitting of d orbitals, CFSE, Jahn Teller effect, charge transfer spectra- spectrochemical series-Term states for d⁰ ions, Orgel and Tanable- sugano diagram, calculation of D_q, B and β parameters.


Bioinorganic Chemistry: Metal ions in Biology, Photosynthesis, PSL, PSH, Nitrogen fixation, Oxygen transport and storage, Heme proteins haemoglobin, cytochrome and ferrodoxins.

Spectroscopy: Applications of nmr,nqr and esr to inorganic compounds.

Unit-5


Unit-6

Unit-7

**Organic synthesis:** Synthesis and any di and trisubstituted benzene derivatives from any mono substituted benzene or benzene itself. Synthesis of simple compounds using C-C bond forming reactions involving Wittig, Wittig Honner, Gilmann Reagents, organolithiums, Grignards, Robinson annulation, Dickmann condensation, Knovenagel, Mannisch, Stork enamine, and Vilsmeeyer reactions and Umplolung. (1,3-dithane). Synthetic transformations involving Swern oxidation, Birch Wolf Kishner and metal hydride reductions, catalytic hydrogenations and reagents like tributyitin hydride, trimethylsilyl iodide, LDA, n-BuLi, Raney nickel, NBS Chromium reagents, DCC and Pd. Application of protective group concept (aldelydes, ketones and carboxylic acids) during multistep synthesis. Spectral identification of organic intermediates by IR (functional group) PMR and CMR and mass spectra. (simple molecules only).

Unit-8

Numbering and synthesis of unsubstituted (parent) and alkyl, aryl or acyl (wherever methods are available) substituted furans, pyrroles, thiophene, quionline, iso quinoline and indoles. Reactivity of these compounds towards electrophiles or nucleophiles. A study of other non benzenoid aromatics (ferrocences, azulenes, annulenes and fulvenes).

Unit 9

electron density and bond order. Semi empirical methods: Slater orbital and HF-SCF methods.


**Unit-10**

**Chemical Kinetics**: Theories of reaction rate, collision theory, ARRT, comparison-potential energy surfaces- treatment of unimolecular reaction.

Complex reactions: simultaneous, parallel and consecutive reactions. Chain reactions: \( \text{H}_2\text{Cl}_2 \) \( \text{H}_2\text{I} \) \( \text{Br}_2 \) branching reaction- explosion limit.

Reactions in solution: factors determining reaction rate in solution, dielectric constant and ionic strength, Kinetic isotopic effect, Linear free energy relations. Hammett and Taft equations.


**Thermodynamics**: First and second Laws of thermodynamics- relation between \( c_p \) and \( c_v \) in terms of coefficients of expansion and compressibility. Maxwell relations-partial molar properties- Glibbs-Duhem equation- variation of chemical potential with temperature and pressure-fugacity- Third law and calculation of entropy.

Statistical thermodynamics: Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distribution- Partition function, translational, rotational and vibrational partition function, calculation of thermodynamic functions, equilibrium constant and heat capacity from partition functions. Einstein and Debye theories of heat capacity of solids., concept of negative absolute temperature.

Nonequilibrium, thermodynamics: Phenomenological laws- Onsagers reciprocity relation- application to Diffusion potential, electrokinetic phenomena- entropy production.

**Unit 11**

**Group theory**: Symmetry elements and symmetry operations, point groups, reducible and irreducible representations î Direct product representation. Orthogonality theorem and its consequences- construction of Character Tale \( C_{2v}\) \( C_{3v} \) and \( C_{2h} \) Applications: Selection rules for IR, Raman and electronic spectra, Determining Symmetries of normal vibrational modes of non linear molecules,
construction of hybrid orbitals, application to electronic spectra of ethylene and formaldehyde.

**Spectroscopy:** Rotational Spectra of rigid and non-rigid diatomic rotors, simple polyatomic molecules.


Electronic Spectroscopy: Spectra of diatomic molecules- Frank condon principle-Morse function. Polyatomic molecules, types of transition, solvent effects.

Spin resonance Spectroscopy: NMR: Origin of nmr signal, Chemical Shift, factors affecting chemical shift and spin spin coupling. NMR Spectra of simple AX and ABX type molecules. $^{13}$C and $^{19}$F nmr.

ESR: Origin, g-factor, hyperfine structure- Mc Connel equations, Theory and simple applications of Mossbauer and Photoelectron Spectroscopy.

**Unit-12**

**Electrochemistry:** Ion-solvent interaction- Born treatment- solvation number and its determination. Ion-ion interaction: activity co-efficient, Debye-Huckel equation for activity coeff - limitations and extension to concentrated solutions. Ion transport: Debye Huckel Orsager equation for conductance- experimental validity. Ion association: its effect on conductance and activity coefficient.


**Photochemistry:** Photophysical processes- Theory of radiationless transition-fluorosence, phosphorescence, fluorescence quenching- Stern-Volmer equation, excimer, exciplexes, Quantum yield measurement, Kinetics of Photochemical reac.