राष्ट्रीय प्रौद्योगिकी संस्थान अगरतला
National Institute of Technology, Agartala
Tripura, India, Pin –799046

Ref. Advt. No.: F. NITA. 2 (521-Estt)/ 2019/ 9766, dated: 26-12-2019 and Subsequent Re-advertisement.

SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN BIO ENGINEERING DEPARTMENT

Section-1: Engineering Mathematics

Linear Algebra: Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

Calculus: Functions of single variable; Limit, continuity and differentiability; Mean value theorems, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

Ordinary Differential Equation (ODE): First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

Partial Differential Equation (PDE): Fourier series; separation of variables; solutions of one- dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

Probability and Statistics: Sampling theorems; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation; Random Variables – Discrete and Continuous, Poisson and Normal Distribution; Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for first order differential equations.

Section 2: General Biology

Biochemistry: Biomolecules - structure and function; Biological membranes - structure, membrane channels and pumps, molecular motors, action potential and transport processes; Basic concepts and regulation of metabolism of carbohydrates, lipids, amino acids and nucleic acids; Photosynthesis, respiration and electron transport chain. Enzymes - Classification, catalytic and regulatory strategies; Enzyme kinetics - Michaelis-Menten equation; Enzyme inhibition - competitive, non-competitive and uncompetitive inhibition.

Microbiology: Bacterial classification and diversity**;** Microbial Ecology - microbes in marine, freshwater and terrestrial ecosystems; Microbial interactions; Viruses - structure and classification**;** Methods in microbiology**;** Microbial growth and nutrition**;** Nitrogen fixation**;** Microbial diseases and host-pathogen interactions; Antibiotics and antimicrobial resistance.

Immunology: Innate and adaptive immunity, humoral and cell mediated immunity; Antibody structure and function; Molecular basis of antibody diversity; T cell and B cell development; Antigen-antibody reaction; Complement; Primary and secondary lymphoid organs; Major histocompatibility complex (MHC); Antigen processing and presentation; Polyclonal and monoclonal antibody; Regulation of immune response; Immune tolerance; Hypersensitivity; Autoimmunity; Graft versus host reaction; Immunization and vaccines.

Section 3: Genetics, Cellular and Molecular Biology

Genetics and Evolutionary Biology: Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extra chromosomal inheritance; Microbial genetics - transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Chromosomal variation; Genetic disorders; Population genetics; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation.

Cell Biology: Prokaryotic and eukaryotic cell structure**;** Cell cycle and cell growth control**;** Cell-cell communication; Cell signaling and signal transduction; Post-translational modifications; Protein trafficking; Cell death and autophagy; Extra-cellular matrix.

Molecular Biology: Molecular structure of genes and chromosomes; Mutations and mutagenesis; Regulation of gene expression; Nucleic acid - replication, transcription, splicing, translation and their regulatory mechanisms; Non-coding and micro RNA; RNA interference; DNA damage and repair.

Section 4: Fundamentals of Biological Engineering

Engineering principles applied to biological systems: Material and energy balances for reactive and non-reactive systems; Recycle, bypass and purge processes; Stoichiometry of growth and product formation; Degree of reduction, electron balance, theoretical oxygen demand.

Classical thermodynamics and Bioenergetics: Laws of thermodynamics; Solution thermodynamics; Phase equilibria, reaction equilibria; Ligand binding; Membrane potential; Energetics of metabolic pathways, oxidation and reduction reactions.

Transport Processes: Newtonian and non-Newtonian fluids, fluid flow - laminar and turbulent; Mixing in bioreactors, mixing time; Molecular diffusion and film theory; Oxygen transfer and uptake in bioreactor, kLa and its measurement; Conductive and convective heat transfer, LMTD, overall heat transfer coefficient; Heat exchangers.

Section 5: Bioprocess Engineering and Process Biotechnology

Bioreaction engineering: Rate law, zero and first order kinetics; Ideal reactors - batch, mixed flow and plug flow; Enzyme immobilization, diffusion effects - Thiele modulus, effectiveness factor, Damkoehler number; Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models; Batch, fed-batch and continuous processes; Microbial and enzyme reactors; Optimization and scale up.

Upstream and Downstream Processing: Media formulation and optimization; Sterilization of air and media; Filtration - membrane filtration, ultrafiltration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity**,** GC, HPLC and FPLC; Extraction, adsorption and drying.

Instrumentation and Process Control: Pressure, temperature and flow measurement devices; Valves; First order and second order systems; Feedback and feed forward control; Types of controllers - proportional, derivative and integral control, tuning of controllers.

Section 6: Plant, Animal and Microbial Biotechnology

Plants: Totipotency; Regeneration of plants; Plant growth regulators and elicitors; Tissue culture and cell suspension culture system - methodology, kinetics of growth and nutrient optimization; Production of secondary metabolites; Hairy root culture; Plant products of industrial importance; Artificial seeds; Somaclonal variation; Protoplast, protoplast fusion - somatic hybrid and cybrid; Transgenic plants - direct and indirect methods of gene transfer techniques; Selection marker and reporter gene; Plastid transformation.

Animals: Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Micro & macro-carrier culture; Hybridoma technology; Stem cell technology; Animal cloning; Transgenic animals; Knock-out and knock-in animals.

Microbes: Production of biomass and primary/secondary metabolites - Biofuels, bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins and metabolites; Clinical-, food- and industrial- microbiology; Screening strategies for new products.

Section 7: Recombinant DNA technology and Other Tools in Biotechnology

Recombinant DNA technology: Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial and yeast artificial chromosomes; Expression vectors; cDNA and genomic DNA library; Gene isolation and cloning, strategies for production of recombinant proteins; Transposons and gene targeting;

Molecular tools: Polymerase chain reaction; DNA/RNA labelling and sequencing; Southern and northern blotting; In-situ hybridization; DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; CRISPR-Cas; Biosensing and biosensors.

Analytical tools: Principles of microscopy - light, electron, fluorescent and confocal; Principles of spectroscopy - UV, visible, CD, IR, fluorescence, FT-IR, MS, NMR; Electrophoresis; Micro-arrays; Enzymatic assays; Immunoassays - ELISA, RIA, immunohistochemistry; immunoblotting; Flow cytometry; Whole genome and ChIP sequencing.

Computational tools: Bioinformatics resources and search tools; Sequence and structure databases; Sequence analysis - sequence file formats, scoring matrices, alignment, phylogeny; Genomics, proteomics, metabolomics; Gene prediction; Functional annotation; Secondary structure and 3D structure prediction; Knowledge discovery in biochemical databases; Metagenomics; Metabolic engineering and systems biology.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN CHEMICAL ENGINEERING DEPARTMENT

1. Engineering Mathematics:

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors. Calculus: Functions of single variable, Limit, continuity and differentiability, Taylor series, 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: Complex number, polar form of complex number, triangle inequality. Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis. Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.

2. Fundamental of Chemical Engineering:

2.1. Process Calculations and Thermodynamics:

Units and conversions, Numerical calculation and estimation, statistical analysis of data, fitting of non-linear data; chemical equation and stoichiometry. Sensible heat effects, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction. First law of Thermodynamics and its applications. Applications of first law to close and open systems. Gibb's phase rule and degree of freedom analysis. Thermodynamic properties of pure substances: PVT behavior of pure substances, Ideal gas law calculation, real gas relationships and its applications, cubic equations of state, virial equation, generalized correlations for gases and liquids. Second law of Thermodynamics: Limitation of first law, Kelvin-Planck and Clausius statements, Reversible and irreversible processes, Carnot cycle, Entropy, Second Law Analysis of a control volume. Maxwell's relations, Clapeyron's Equation. Multicomponent systems: Chemical potential, ideal-gas mixture, ideal solution, Raoult's law. Partial properties, fugacity and fugacity coefficient, generalized correlations for the fugacity coefficient, excess Gibbs' energy, activity coefficient. Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients. Phase Equilibria: Phase rule, phase behavior for vapor liquid systems,

Margules equation, Van-Laar equation, Wilson equation, NRTL equation. Dew point, bubble point and flash calculations. phase equilibria: predicting VLE of systems; chemical reaction equilibrium. Effect of temperature on the equilibrium constant, evaluation of equilibrium constants. Relations between equilibrium constants and compositions: gas-phase reactions, liquid-phase reactions. Material balance of processes with and without chemical reaction, including recycle, purge and bypass. Energy Balances: Calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing. Steady and unsteady state mass and energy balances including multiphase, multi- component, reacting and non - reacting systems; vapour pressure and liquids, saturation, partial saturation and humidity, humidification and dehumidification operations, psychometric chart.

2.2. Fluid Mechanics and Mechanical Operations:

Continuity equation for compressible and incompressible fluids. Bernoulli's equation, Euler's equation, introduction to Navier-Stokes equation. Steady and unsteady, laminar and turbulent flows, Relationship between shear stress and pressure gradient, Hagen-Poiseuille equation. Prandtl's mixing length theory and eddy diffusivity losses in pipes and fittings, Darcy-Weisbach equation for frictional head loss, Moody diagram. Velocity profile and boundary layer calculations for turbulent flow.

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, 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; Flow measuring devices such as orifice meter, venturimeter and rotameter.

Size Reduction: Classification of solid particles Principles of crushing and grinding, Determination of mean particle size and size distribution, Laws of crushing and grinding, Energy required for size reduction, crushing and grinding equipment, closed and open circuit grinding. Types of screens, mesh number and size distribution, different types of screening, effectiveness of screen, Particle size analysis, Particle size and shape, particle size distribution, separation efficiency and screening equipment. Solid-Liquid Separation: Theory of filtration, filtration equipment, equations for compressible and incompressible cakes, Constant volume and Constant pressure filtration, press filter, rotary drum and vacuum filter. Fiber and fabric filters. Free and hindered settling, sedimentation, classifiers, thickeners and Principles and applications of thickening. Centrifuges- Principles and applications. Solid-Gas Separation: Cyclone separators and electrostatic precipitator. Principles and applications of agitation and mixing; conveying of solids.

2.3. Heat Transfer Operations:

Modes of heat transfer: conduction, convection, radiation. Fourier's law, thermal conductivity, steady-state conduction of heat through a composite solid, cylinder and sphere. Steady-state heat conduction in bodies with heat sources: plane wall, cylinder and sphere. Convective heat transfers and the concept of heat transfer coefficient, overall heat transfer coefficient, heat transfer from extended surfaces, thermal contact resistance, critical insulation thickness, optimum insulation thickness. Forced convection: Flow over a flat plate, thermal boundary

layer, flow across a cylinder. Dimensional analysis: Buckingham Pi theorem, Dimensional groups in heat transfer. Correlations for the heat transfer coefficient: Laminar flow through a circular pipe, turbulent flow through a circular pipe, flow through a non-circular duct, flow over flat plate, flow across a cylinder, flow past a sphere, flow across a bank of tubes, heat transfer coefficient in a packed and fluidized bed. Free convection: Introduction, heat transfer correlations for free convection: flat surface, cylinder, sphere, enclosure. Combined free and forced convection. Black body radiation, Planck's Law, Wien's Displacement Law, Stefan-Boltzmann Law, Kirchhoff's Law, Gray body. Radiation intensity of a black body, spectral emissive power of a black body over a hemisphere. 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.

2.4. Mass Transfer Operations and Transport Phenomenon:

Fick's laws, molecular diffusion in fluids, Molecular diffusion, fluxes and measurement of diffusivities. Mass transfer coefficients, laminar and turbulent flow situations and correlations. Film, penetration and surface renewal theories: Two film theory and overall mass transfer coefficients, penetration and surface renewal theories. Concepts of equilibrium stage, operating line and tie line. Momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies. Continuous contacting operations: Gas absorption - countercurrent isothermal, HETP, design equation, (L/G) min, NTU, HTU, calculation of NTU, HTU & NTU concepts. Design and operation of equipment for distillation, packed tower distillation, flooding, AP, liquid and gas distributors, entrainment eliminators. Humidification and dehumidification, cooling towers, drying theory and design, crystallization. Binary distillation: ideal and non- ideal stages; definitions of point, stage and column efficiencies. Single stage calculations: differential (Rayleigh) and simple (flash) distillation, steam distillation. Ponchon- Savarit diagram, McCabe-Thiele diagram; plate calculations, Absorption, Liquid-liquid extraction, Adsorption and Leaching. Membrane Separation Processes: Physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Osmosis and osmotic pressure. Working principle and operation of Reverse osmosis. Concept of Momentum, Heat and Mass Transport through Transport Phenomena - Assumptions of Transport phenomena; Similarity of Mass, Momentum and Energy transfer, Diffusivities, Transport Theorem. Vectors & Tensors: Geometric representation of vectors; Einstein summation convention; Basic review of vector algebra; Representation using Kronecker delta and alternating unit tensor; Review of vector calculus. Tensors: dyadic products with another tensor, vector; tensor operations required for stress analysis. Momentum Transport, Energy Transport. Mass Transport. Concept of coupled equations.

2.5. 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, single parameter model; non-isothermal reactors. Reaction rates, variables affecting reaction

rates, classification of reactions, order, molecularity. Reaction mechanism & Kinetics of homogenous reactions. Temperature dependent term of a rate equation. Interpretation of batch reactor data: constant volume batch reactor, variable volume batch reactor. Ideal reactors for single reaction: Ideal batch reactor, steady state mixed flow reactor, steady state PFR, holding time and space time for flow systems. Design for single reactions: size comparison, multiple reactor systems, recycle reactor, auto catalytic reactions. Temperature and pressure effects on single reactions. Non-ideal flow: Residence time distribution of fluids, general characteristics, Measurement of RTD, RTD in ideal reactor, Tanks-in-series model. Catalysts: Description, methods of preparation and manufacture; catalyst characterization — BET surface area, pore volume, pore size distribution. Kinetics of heterogeneous catalytic reactions. Catalyst reaction kinetic models: Physical and chemical adsorption; Determination of rate expressions using adsorption, surface reaction and desorption as rate controlling steps. Diffusion effects in catalysis. Determination of Global rate of reaction: Heterogeneous laboratory reactors; Determination of rate expressions from experimental data. Effect of intra-pellet diffusion on reaction rates in isothermal pellets. Gas-liquid reactions: Effect of diffusion on rate of reaction, enhancement factor. Introduction to design of heterogeneous reactors and its parametric sensitivity.

2.6. Instrumentation and Process Control:

First-order systems: Transfer function, transient response, response of first -order systems in series: non-interacting systems and interacting systems. Second-order systems: Transfer function, step response, impulse response, sinusoidal response, transportation lag. Linear closed-loop systems: Components of a control system, block diagram, negative feedback and positive feedback, servo problem and regulator problem.

Measurement of process variables; sensors, transducers and their dynamics, process modeling 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, controller tuning, cascade and feed forward control. Controller and final control element: Mechanism of control valve and controller, transfer functions of control valve and controllers (P, PI, PD, PID). Closed-loop transfer functions: Overall transfer function for single-loop systems, overall transfer function for set-point change and load change, multi-loop control systems. Transient response of simple control systems: P and PI control for set-point change and for load change. Concept of stability; stability criteria; Routh test for stability; Root locus. Introduction to frequency response, Bode diagrams for first and second order systems, Bode stability criteria, Ziegler-Nichols and Cohen-Coon tuning rules.

2.7. Plant Design and Engineering Economics:

Process design development and general design considerations. 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 equipments such as compressors, heat exchangers, multistage contactors. Process Economics: economic feasibility of project using order-of-magnitude cost estimates, plant and equipment cost estimation, product cost estimation. Time value of

money, investment, costs, sales, profits, taxes, depreciation. Rate of return, payback period, discount rate of return, net present worth, internal rate of return, comparing investment alternatives.

2.8. Chemical Technology:

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); construction materials industries (iron-steel, cement) organic chemical industries, petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

2.9. Industrial Pollution Control and Process Safety:

Standards and legislation: Environmental laws and regulations; Pollution & environmental ethics, Environmental root analysis : risk, assessment of risk, expression of risk, ecosystem risk management, , Impact assessment, Wastewater Treatment: Characterization of industrial wastewater, primary, secondary and tertiary treatment, segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electrodialysis, sludge dewatering and disposal methods. Air Pollution Control: Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, pollutants from automobiles. Solid and hazardous waste management, Management of acoustic pollution.

Safety program, engineering ethics, accident and loss statistics. Classification of chemicals, transportation of chemicals, receiving and storing chemicals, work permit systems, pipe lines in chemical factories, colour coding of chemical pipe lines, reactors: run away reactions, control, precaution and prevention, inherent safety. Emergency planning, Mood's toxicity index, inspection techniques for plants, reaction vessels, check list for routine checks, checklist for specific maintenance and breakdown. Fires and explosions, flammability characteristics of liquids and vapours, ignition energy, auto ignition, auto oxidation, explosion proof equipment and instruments, ventilation, sprinkler systems.

2.10. Materials and technologies related to Chemical Engineering:

Classes of engineering materials, engineering requirement of materials, selection of materials, structure of atoms and molecules, bonding in solids. Corrosion of materials - theories of corrosion, control and prevention of corrosion. Phase and transformations. Elastic and plastic deformation in the materials. Composites materials, nanotechnology and advanced materials. Thermal, electrical, optical and magnetic properties- solar cells, superconductors, polarization, frequency and temperature dependence of dielectric constant, piezo and ferroelectricity, optical absorption, optoelectronic materials. Ferri and ferromagnetism, soft and hard magnetic materials. Materials for energy: Solid fuels,Liquid fuels, Gaseous fuels, Combustion: Combustion of fuels, Biomass materials for bioenergy.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN CHEMISTRY DEPARTMENT

Section A: Physical Chemistry:

1. Basic principles of quantum mechanics: Postulates of quantum mechanics. Operators. Time dependent and time independent Schrödinger equations. Born interpretation. Dirac bra-ket notation. Particle in a box: infinite and finite square wells; concept of tunnelling; particle in 1D, 2D and 3D-box; applications. Harmonic oscillator: harmonic and anharmonic potentials; hermite polynomials. Rotational motion: Angular momentum operators, Rigid rotor. Hydrogen and hydrogen-like atoms: atomic orbitals; radial distribution function. Multi-electron atoms: orbital approximation; electron spin; Pauli exclusion principle; slater determinants.

2. Approximation Methods of quantum mechanics: Variation method and secular determinants; first order perturbation techniques. Atomic units.

3. Molecular structure and Chemical bonding: Born-Oppenheimer approximation. Valence bond theory and linear combination of atomic orbitals – molecular orbital (LCAO-MO) theory. Hybrid orbitals. Applications of LCAO-MO theory to H_2^+, H_2 ; molecular orbital theory (MOT) of homo- and heteronuclear diatomic molecules. Huckel theory for conjugated π-electron systems.

4. Group theory: Symmetry elements and operations; Point groups and character tables; Internal coordinates and vibrational modes; symmetry adapted linear combination of atomic orbitals (LCAO-MO); construction of hybrid orbitals using symmetry aspects.

5. Atomic structure and spectroscopy: Russell-Saunders coupling; Term symbols and spectral details; origin of selection rules and antisymmetry principle.

6. Molecular spectroscopy: Rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Line broadening. Einstein's coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Basic principles of nuclear magnetic resonance: gyromagnetic ratio; chemical shift, nuclear coupling.

7. Chemical Thermodynamics and chemical equilibria: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Standard states. Thermochemistry. Thermodynamic functions and theirn relationships: Gibbs-Helmholtz and Maxwell relations, Gibbs-Duhem equationvan't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Ideal and Non-ideal solutions, Raoult's Law and Henry's Law, Dependence of equilibrium constant on temperature and pressure. Clausius-Clapeyron equation.

8. Statistical thermodynamics: Microcanonical, canonical and grand canonical ensembles Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

9. Conductance and Electrochemistry: Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Nernst Equation and its application, relationship between Electrode potential and thermodynamic quantities, Potentiometric and conductometric titrations

10. Phase rule: Phase diagram of one component systems: CO_2, H_2O ,S; two component systems: liquid- vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics.

11. Chemical Kinetics: Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Unimolecular reactions. Potential energy surfaces and classical trajectories, Concept of Saddle points, Transition state theory: Eyring equation, thermodynamic aspects. Kinetics of polymerization. Catalysis concepts and enzyme catalysis. Kinetic isotope effects. Fast reaction kinetics: relaxation and flow methods. Diffusion controlled reactions. Kinetics of photochemical and photophysical processes.

12. Surfaces and Interfaces: Physisorption and chemisorption. Langmuir, Freundlich and Brunauer–Emmett– Teller (BET) isotherms. Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity. Self- assembly. Physical chemistry of colloids, micelles and macromolecules.

13. Polymer chemistry: Molar masses; kinetics of polymerization.

14: Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Section B: Inorganic Chemistry:

1. Basic concepts of Inorganic Chemistry: Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory). Acid-base concepts and principles (Lewis, Brønsted, HSAB and acid-base catalysis) and non-aqueous solvents.

2. Main Group Elements: Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon, phosphorous and sulphur. Industrial synthesis of compounds of main group elements. Chemistry of noble gases, pseudohalogens, and interhalogen compounds.

3. Transition Elements: Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, CFSE, applications of CFT, Jahn-Teller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel and Tanabe- Sugano diagrams,

nephelauxetic effect and Racah parameter, charge-transfer spectra. Magnetic properties of transition metal complexes. Ray-Dutt and Bailar twists, Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions. Metal-metal multiple bond.

4. Lanthanides and Actinides: Recovery. Periodic properties, spectra and magnetic properties.

5. Organometallics: 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal-carbene complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis - Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis - Fischer- Tropsch reaction, Ziegler-Natta polymerization. Radioactivity: Detection of radioactivity, Decay processes, half-life of radioactive elements, fission and fusion processes.

6 Bioinorganic Chemistry: Ion (Na^+ and K^+) transport, Photosynthesis, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes containing magnesium, molybdenum, iron, cobalt, copper and zinc, metal

7. Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX_2 , ABX_3 type compounds, spinels, band theory, metals and semiconductors.

8. Instrumental Methods of Analysis: UV-visible, fluorescence and FTIR spectrophotometry, NMR and ESR spectroscopy, mass spectrometry, atomic absorption spectroscopy, Mössbauer spectroscopy (Fe and Sn) and X- ray crystallography. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.

9. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis

Section C: Organic Chemistry:

1. Nomenclature of organic molecule and aromaticity : IUPAC nomenclature of organic molecules including regio- and stereoisomers, Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.

2. Stereochemistry: Chirality and symmetry of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism and optical isomerism. Configurational and conformational effects, atropisomerism, and neighbouring group participation on reactivity and selectivity/specificity.

3. Organic reactive intermediates: Basic mechanistic concepts – kinetic versus thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through kinetics, identification of products, intermediates and isotopic labelling. Linear free-energy relationship – Hammett and Taft equations. Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

4. Oragnic reaction Mechanisms: Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways. Common named reactions and rearrangements – applications in organic synthesis.

5. Organic transformations and reagents: Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, Li, Cu, B, Zn, P, S, Sn and Si based reagents in organic synthesis. Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry. Carbon- carbon and carbon-heteroatom bond forming reactions through enolates (including boron enolates), enamines and silyl enol ethers. Stereoselective addition to C=O groups (Cram, Prelog and Felkin-Anh models).

6. Concept of organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

7. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst-controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.

8. Pericyclic Reactions and Photochemistry: Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlations - FMO and PMO treatments, Woodward-Hoffmann rule. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Di-π-methane rearrangement, Barton-McCombie reaction, Norrish type-I and II cleavage reaction.

9: Heterocyclic Compounds: Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

10. Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, chemical structure determination of peptides and proteins, structural features of proteins, nucleic acids, lipids, steroids, terpenoids, carotenoids, and alkaloids. Biogenesis of terpenoids and alkaloids.

11. Experimental techniques in organic chemistry: Optical rotation (polarimetry). Applications of various chromatographic techniques such as thin-layer, column, HPLC and GC. Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

Section D: Interdisciplinary topics:

1. Chemistry in nanoscience and technology-Basic concept: Top-down and bottom-up approach to synthesis of nanomaterials, Fullerenes: Carbon nanotubes, Graphene. Application of nanomaterials as solar cell and lithium-ion batteries, drug delivery; bio-conjugation and sensing.

2. Catalysis and green chemistry: Need for green chemistry; inception and evolution of green chemistry; twelve principles of green chemistry with their explanations and examples; designing a green synthesis using these principles; green chemistry in day-to-day life

3. Medicinal chemistry: Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery. Drugs based on a substituted benzene ring, five-membered heterocycles, six-membered heterocycles, seven-membered heterocyclic rings fused to benzene, heterocycles fused to two benzene rings, β-Lactam antibiotics.

4. Supramolecular chemistry: Concepts and development, Nature of binding interactions in supramolecular structures, Host–guest Chemistry**:** Synthesis and structures of crown ethers, Lariat ethers, Podands, Cryptands, Spherands, Calixarene, Cyclodextrins, Cyclophanes, Cryptophanes, Carcerands and hemicarcerands, Host-guest interactions, Preorganisation and complimentarity, Lock and key analogy, Binding of cationic, Anionic, Ion pair and neutral guest molecules. Self-assembly and Molecular device.

5. Environmental chemistry: Environmental terminology, Chemical toxicology: Air Pollution, Water pollution and social issues and Environment law.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN CIVIL ENGINEERING

Engineering Mathematics

Linear Algebra: Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

Calculus: Functions of single variable; Limit, continuity and differentiability; Mean value theorems, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

Ordinary Differential Equation (ODE): First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

Partial Differential Equation (PDE): Fourier series; separation of variables; solutions of one- dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

Probability and Statistics: Sampling theorems; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation; Random Variables – Discrete and Continuous, Poisson and Normal Distribution; Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for first order differential equations.

Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Pre stressed concrete beams. Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis -beams and frames.

Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils – Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.

Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.

Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.

Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

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

Transportation Engineering

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments. Geometric design of railway Track – Speed and Cant.
Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.
Highway Pavements: Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes

Traffic Engineering: Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections; Highway capacity.

Geomatics Engineering: Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station;

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN Computer Science & Engineering and Master of Computer Applications (MCA)

Discrete Mathematical Structures:

Mathematical Logic: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference.

Sets and Relations:

Counting, Mathematical Induction and Discrete Probability: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion- Exclusion Principle, Mathematical Induction, Probability, Bayes'Theorem.

Group Theory, Graph Theory, Boolean Algebra

Computer System Architecture:

Digital Logic Circuits and Components: Digital Computers, Logic Gates, Boolean Algebra, Map Simplifications, Combinational Circuits, Flip-Flops, Sequential Circuits, Integrated Circuits, Decoders, Multiplexers, Registers and Counters, Memory Unit.

Data Representation: Data Types, Number Systems and Conversion, Complements, Fixed Point Representation, Floating Point Representation, Error Detection Codes, Computer Arithmetic - Addition, Subtraction, Multiplication and Division Algorithms.

Register Transfer and Micro operations: Register Transfer Language, Bus and Memory Transfers, Arithmetic, Logic and Shift Micro operations.

Basics Computer Organization

Programming the Basic Computer: Machine Language, Assembly Language, Assembler, Program Loops, Subroutines, Input-Output Programming.

Microprocessor:

Central Processing Unit, Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing Array Processors.

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Serial Communication.
Memory Hierarchy, Multiprocessors.

Programming Languages and Computer Graphics:

Language Design and Translation Issues: Programming Language Concepts, Paradigms and Models, Programming Environments, Virtual Computers and Binding Times, Programming Language Syntax, Stages in Translation, Formal Transition Models.

Elementary Data Types,

Programming in C: Tokens, Identifiers, Data Types, Sequence Control, Subprogram Control, Arrays, Structures, Union, String, Pointers, Functions, File Handling, Command Line Argumaents, Preprocessors.

Object Oriented Programming: Class, Object, Instantiation, Inheritance, Encapsulation, Abstract Class, Polymorphism.

Programming in C++: Tokens, Identifiers, Variables and Constants; Data types, Operators, Control statements, Functions Parameter Passing, Virtual Functions, Class and Objects; Constructors and Destructors; Overloading, Inheritance, Templates, Exception and Event Handling; Streams and Files; Multifile Programs.

Web Programming: HTML, DHTML, XML, Scripting, Java, Servlets, Applets.

Computer Graphics: Video-Display Devices, Raster-Scan and Random-Scan Systems; Graphics Monitors, Input Devices, Points and Lines; Line Drawing Algorithms, Mid-Point Circle and Ellipse Algorithms; Scan Line Polygon Fill Algorithm, Boundary-Fill and Flood- Fill.

Database Management Systems

Database System Concepts and Architecture: Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS.

Data Modeling: Entity-Relationship Diagram, Relational Model - Constraints, Languages, Design, and Programming, Relational Database Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules.

SQL: Data Definition and Data Types; Constraints, Queries, Insert, Delete, and Update Statements; Views, Stored Procedures and Functions; Database Triggers, SQL Injection.

Normalization for Relational Databases: Functional Dependencies and Normalization; Algorithms for Query Processing and Optimization; Transaction Processing, Concurrency Control Techniques, Database Recovery Techniques, Object and Object-Relational Databases; Database Security and Authorization.

Data Warehousing and Data Mining: Data Modeling for Data Warehouses, Concept Hierarchy, OLAP and OLTP; Association Rules, Classification, Clustering, Regression,

Support Vector Machine, K-Nearest Neighbour, Hidden Markov Model, Summarization, Dependency Modeling, Link Analysis, Sequencing Analysis, Social Network Analysis.

System Software and Operating System:

System Software: Machine, Assembly and High-Level Languages; Compilers and Interpreters; Loading, Linking and Relocation; Macros, Debuggers.

Basics of Operating Systems, Process Management, Threads, CPU Scheduling, Deadlocks

Memory Management, Storage Management: Mass-Storage Structure, Disk Structure, Scheduling and Management, RAID Structure.

File and Input/Output Systems

Security: Protection, Access Matrix, Access Control, Revocation of Access Rights, Program Threats, System and Network Threats; Cryptography as a Security Tool, User Authentication, Implementing Security Defenses.

Linux Operating Systems, Windows Operating Systems

Distributed Systems: Types of Network based Operating Systems, Network Structure, Communication Structure and Protocols; Robustness, Design Issues, Distributed File Systems.

Software Engineering:

Software Process Models: Software Process, Generic Process Model – Framework Activity, Task Set and Process Patterns; Process Lifecycle, Prescriptive Process Models, Project Management, Component Based Development, Aspect-Oriented Software Development, Formal Methods, Agile Process Models – Extreme Programming (XP), Adptive Software Development, Scrum, Dynamic System Development Model, Feature Driven Development, Crystal, Web Engineering**.**

Software Requirements , Software Design, Software Quality

Estimation and Scheduling of Software Projects: Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing; Time-line Charts.

Software Testing

Software Configuration Management: Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering.

Data Structures and Algorithms:

DataStructures: ArraysandtheirApplications;SparseMatrix,Stacks,Queues,PriorityQueues,Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Data Structure for Sets, Graphs, Sorting and Searching Algorithms; Hashing.

Performance Analysis of Algorithms and Recurrences: Time and Space Complexities; Asymptotic Notation, Recurrence Relations.

Design Techniques: Divide and Conquer; Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound.

Lower Bound Theory, Graph Algorithms: Breadth-First Search, Depth-First Search, Shortest Paths, Maximum Flow, Minimum Spanning Trees.

Complexity Theory: P and NP Class Problems; NP-completeness and Reducibility.

Theory of Computation and Compilers:

Theory of Computation: Formal Language, Non-Computational Problems, Diagonal Argument, Russels's Paradox.

Regular Language Models: Deterministic Finite Automaton (DFA), Non-Deterministic Finite Automaton (NDFA), Equivalence of DFA and NDFA, Regular Languages, Regular Grammars, Regular Expressions, Properties of Regular Language, Pumping Lemma, Non- Regular Languages, Lexical Analysis.

Context Free Language, Turing Machines (TM)

Syntax Analysis, Semantic Analysis: Attribute Grammar, Syntax Directed Definitions, Inherited and Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L-attributed Definitions; Type- Checking.

Run Time System: Storage Organization, Activation Tree, Activation Record, Stack Allocation of Activation Records, Parameter Passing Mechanisms, Symbol Table.

Intermediate Code Generation: Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls.

Code Generation and Code Optimization: Control-flow, Data-flow Analysis, Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization, Instruction Scheduling.

Data Communication and Computer Networks:

Data Communication: Components of a Data Communication System, Simplex, Half-Duplex and Duplex Modes of Communication; Analog and Digital Signals; Noiseless and Noisy Channels; Bandwidth, Throughput and Latency; Digital and Analog Transmission; Data Encoding and Modulation Techniques; Broadband and Baseband Transmission; Multiplexing, Transmission Media, Transmission Errors, Error Handling Mechanisms.

Computer Networks: Network Topologies, Local Area Networks, Metropolitan Area Networks, Wide Area Network, Wireless Networks, Internet.

Network Models: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses; Switching Techniques.

Functions of OSI and TCP/IP Layers, World Wide Web (WWW)

Network Security: Malwares, Cryptography and Steganography; Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN ELECTRONICS AND COMMUNICATION ENGINEERING

Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra, eigenvalues and eigenvectors, rank, solution of linear equations- existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.

Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stokes' theorems.

Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, sequences, series, convergence tests, Taylor and Laurent series, residue theorem.

Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability.

Networks, Signals and Systems:

Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity.

Sinusoidal steady state analysis: phasors, complex power, maximum power transfer.

Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.

Linear 2-port network parameters, wye-delta transformation.

Continuous-time signals: Fourier series and Fourier transform, sampling theorem and applications.
Discrete-time signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals.
LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Electronic Devices:

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

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, LED, photo diode and solar cell.

Analog Circuits:

Diode circuits: clipping, clamping and rectifiers.

BJT and MOSFET amplifiers: biasing, ac coupling, small signal analysis, frequency response.

Current mirrors and differential amplifiers.

Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Digital Circuits:

Number representations: binary, integer and floating-point- numbers.

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.

Sequential circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

Data converters: sample and hold circuits, ADCs and DACs.
Semiconductor memories: ROM, SRAM, DRAM.

Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

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 compensation; State variable model and solution of state equation of LTI systems.

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, superheterodyne receivers.

Information theory: entropy, mutual information and channel capacity theorem.

Digital communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER.

Fundamentals of error correction, Hamming codes, CRC.

Electromagnetics:

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.

Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN ELECTRICAL ENGINEERING DEPARTMENT

Section 1: Electric Circuits

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, The venin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Section 2: Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magneto motive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Section 3: Signals and Systems

Representation of continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform.

Section 4: Electrical Machines

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

Section 5: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and

insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Section 6: Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Section 7: Electrical and Electronic Measurements

Bridges and Potentiometer, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Section 8: Analog and Digital Electronics

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; 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, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085Microprocessor: Architecture, Programming and Interfacing.

Section 9: Power Electronics

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN ELECTRONICS AND INSTRUMENTATION ENGINEERING

Engineering Mathematics

Linear Algebra: Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

Calculus: Functions of single variable; Limit, continuity and differentiability; Mean value theorems, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

Ordinary Differential Equation (ODE): First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

Partial Differential Equation (PDE): Fourier series; separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

Probability and Statistics: Sampling theorems; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation; Random Variables – Discrete and Continuous, Poisson and Normal Distribution; Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for first order differential equations.

Electricity and Magnetism: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Electrical Circuits and Machines: Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, mutual inductance and capacitor; transient analysis of RLC circuits with dc excitation.

Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems.

Peak-, average- and rms values of ac quantities; apparent-, active- and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements. Transient analysis of RLC circuits with ac excitation.

One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters.

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Types of losses and efficiency calculations of electric machines.

Signals and Systems: Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; convolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

Control Systems: Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, PI, PID, cascade, feedforward, and ratio controllers, tuning of PID controllers and sizing of control valves.

Analog Electronics: Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits. Oscillators, signal generators, voltage controlled oscillators and phase locked loop, sources and effects of noise and interference in electronic circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip- flops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to- digital (successive approximation, integrating, flash and sigma-delta) and digital-to- analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems.

Embedded Systems: Microprocessor and microcontroller applications, memory and input-output interfacing; basics of data acquisition systems, basics of distributed control systems (DCS) and programmable logic controllers (PLC).

Measurements: SI units (R, L, C, voltage, current and frequency), systematic and random errors in measurement, expression of uncertainty - accuracy and precision, propagation of errors, linear and weighted regression. Bridges: Wheatstone, Kelvin, Megohm, Maxwell, Anderson, Schering and Wien for measurement of R, L, C and frequency, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

Sensors and Industrial Instrumentation: Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (variable head, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement. 4-20 mA two-wire transmitter.

Communication and Optical Instrumentation: Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing, amplitude-, phase-, frequency-, quadrature amplitude, pulse shift keying for digital modulation; optical sources and detectors: LED, laser, photo-diode, light dependent resistor, square law detectors and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing. UV-VIS Spectro photometers, Mass spectrometer.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN MATHEMATICS DEPARTMENT

Analysis: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum, Sequences and series, convergence, limsup, liminf, Bolzano Weierstrass theorem, Heine Borel theorem, Continuity, uniform continuity, differentiability, mean value theorem, Sequences and series of functions, uniform convergence, Riemann sums and Riemann integral, Improper Integrals, Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral, Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, Metric spaces, compactness, connectedness. Normed Linear Spaces, Spaces of Continuous functions as examples.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations, Algebra of matrices, rank and determinant of matrices, linear equations, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms, Inner product spaces, orthonormal basis, Quadratic forms, reduction and classification of quadratic forms.

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions such as exponential, trigonometric and hyperbolic functions, Analytic functions, Cauchy-Riemann equations, Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem, Taylor series, Laurent series, calculus of residues, Conformal mappings, Mobius transformations.

Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements, Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems, Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, Polynomial rings and irreducibility criteria, Fields, finite fields, field extensions.

Number theory: Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots.

Ordinary Differential Equations (ODEs): Existence and Uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs, General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function

Partial Differential Equations (PDEs): Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs, Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Numerical Analysis: Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Calculus of Variations: Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigen functions, resolvent kernel.

Probability theory: Measures of central tendency, Measures of dispersion, Skewness & Kurtosis, Classical theory of probability, Bayes theorem, Probability function, Random variable and distribution functions, Binomial, Poisson, Normal distributions, Mathematical expectation, moment generating function, Correlation and Regression, Curve fitting, Regression

Linear Programming: Linear programming models, convex sets, extreme points, Basic feasible solution, graphical method, simplex method, two phase methods, revised simplex method ; Infeasible and unbounded linear programming models, alternate optima; Duality theory, weak duality and strong duality; Balanced and unbalanced transportation problems, Initial basic feasible solution of balanced transportation problems (least cost method, north-west corner rule, Vogel's approximation method)

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN MECHANICAL ENGINEERING DEPARTMENT

Engineering Mechanics: Free-body diagrams and equilibrium; friction and its applications including rollingfriction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work;kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) andenergy formulations; Lagrange's equation.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress andplane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept ofshear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermalstresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness andimpact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis oflinkages; 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.

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 andsliding contact bearings, brakes and clutches, springs.

Fluid Mechanics: Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; controlvolume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity andmomentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer,elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressiblefluid flow.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electricalanalogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermalboundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlationsfor flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTUmethods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, viewfactors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal andreal gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; secondlaw of thermodynamics; thermodynamic property charts and tables, availability and irreversibility;thermodynamic relations.

Applications of Fluid Mechanics and Thermal Sciences: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts ofregeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and airconditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart,basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Peltonwheel, Francis and Kaplan turbines; steam and gas turbines.

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stressstrain diagrams for engineering materials.

Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores;solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot andcold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deepdrawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing,soldering and adhesive bonding.

Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-pointcutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of nontraditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes;NC/CNC machines and CNC programming.

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators;interferometry; form and finish measurement; alignment and testing methods; tolerance analysis inmanufacturing and assembly; concepts of coordinate-measuring machine (CMM).

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

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materialsrequirement planning; lean manufacturing.

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

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

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN MHSS

1. ECONOMICS

Micro Economics: Theory of Consumer Behavior, Theory of Production and Costs, Decision making under uncertainty Attitude towards Risk, Game Theory – Non Cooperative games, Market Structures, competitive and non-competitive equilibria and their efficiency properties, Factor Pricing, General Equilibrium Analysis, Efficiency Criteria: Pareto-Optimality, Kaldor – Hicks and Wealth Maximization, Welfare Economics: Fundamental Theorems, Social Welfare Function, Asymmetric Information: Adverse Selection and Moral Hazard.

Macro Economics: National Income: Concepts and Measurement, Determination of output and employment: Classical & Keynesian Approach, Consumption Function, Investment Function, Multiplier and Accelerator, Demand for Money, Supply of Money, IS – LM Model Approach, Inflation and Phillips Curve Analysis, Business Cycles, Monetary and Fiscal Policy, Rational Expectation Hypothesis and its critique.

Statistics and Econometrics: Probability Theory: Concepts of probability, Distributions, Moments, Central Limit theorem, Descriptive Statistics – Measures of Central tendency & dispersions, Correlation, Index Numbers, Sampling methods & Sampling Distribution, Statistical Inferences, Hypothesis testing, Linear Regression Models and their properties – BLUE, Identification Problem, Simultaneous Equation Models – recursive and non-recursive, Discrete choice models, Time Series Analysis.

Mathematical Economics: Sets, functions and continuity, sequence, series, Differential Calculus and its Applications, Linear Algebra – Matrices, Vector Spaces, Static Optimization Problems and their applications, Input-Output Model, Linear Programming, Difference and Differential equations with applications.

International Economics: International Trade: Basic concepts and analytical tools, Theories of International Trade, International Trade under imperfect competition, Balance of Payments: Composition, Equilibrium and Disequilibrium and Adjustment Mechanisms, Exchange Rate: Concepts and Theories, Foreign Exchange Market and Arbitrage, Gains from Trade, Terms of Trade, Trade Multiplier, Tariff and Non-Tariff barriers to trade; Dumping, GATT, WTO and Regional Trade Blocks; Trade Policy Issues, IMF & World Bank.

Public Economics: Market Failure and Remedial Measures: Asymmetric Information, Public Goods, Externality, Regulation of Market – Collusion and Consumers' Welfare, Public Revenue: Tax & Non-Tax Revenue, Direct & Indirect Taxes, Progressive and non-Progressive Taxation, Incidence and Effects of Taxation, Public expenditure, Public Debt and its management, Public Budget and Budget Multiplier, Fiscal Policy and its implications.

Money and Banking: Components of Money Supply, Central Bank, Commercial Banking, Instruments and Working of Monetary Policy, Non-banking Financial Institutions, Capital Market and its Regulation.

Growth and Development Economics: Economic Growth and Economic Development, Theories of Economic Development: Adam Smith, Ricardo, Marx, Schumpeter, Rostow, Balanced & Unbalanced growth, Big Push approach. Models of Economic Growth: Harrod-Domar, Solow, Robinson, Kaldor, Technical progress – Disembodied & embodied; endogenous growth, Indicators of Economic Development: PQLI, HDI,

SDGs, Poverty and Inequalities – Concepts and Measurement, Social Sector Development: Health, Education, Gender,

Environmental Economics and Demography: Environment as a Public Good, Market Failure, Coase Theorem, Cost-Benefit Analysis and Compensation Criteria, Valuation of Environmental Goods, Theories of Population, Concepts and Measures: Fertility, Morbidity, Mortality, Age Structure, Demographic Dividend, Life Table, Migration,

Indian Economy: Economic Growth in India: Pattern and Structure, Agriculture: Pattern & Structure of Growth, Major Challenges, Policy, Responses, Industry: Pattern & Structure of Growth, Major Challenges, Policy Responses, Services: Pattern & Structure of Growth, Major Challenges, Policy Responses, Rural Development – Issues, Challenges & Policy Responses, Urban Development – Issues, Challenges and Policy Responses. Foreign Trade: Structure and Direction, BOP, Flow of Foreign, Capital, Trade Policies, Infrastructure Development: Physical and Social; Public-Private Partnerships, Reforms in Land, Labour and Capital Markets, Centre-State Financial Relations and Finance Commissions of India; FRBM, Poverty, Inequality & Unemployment.

2. ENGLISH

Unit –I : Drama
Unit –II : Poetry
Unit –III : Fiction, short story
Unit –IV : Non-Fictional Prose

NOTE: The first four units must also be tested through comprehension passages to assess critical reading, critical thinking and writing skills. These four units will cover all literatures in English.

Unit –V : Language: Basic concepts, theories and pedagogy. English in Use.
Unit –VI : English in India: history, evolution and futures
Unit –VII : Cultural Studies Unit –VIII : Literary Criticism
Unit –IX : Literary Theory post World War II
Unit –X : Research Methods and Materials in English

3. MANAGEMENT

Unit – I

Management – Concept, Process, Theories and Approaches, Management Roles and Skills
Functions – Planning, Organizing, Staffing, Coordinating and Controlling. Communication – Types, Process and Barriers.
Decision Making – Concept, Process, Techniques and Tools
Organisation Structure and Design – Types, Authority, Responsibility, Centralisation, Decentralisation and Span of Control
Managerial Economics – Concept & Importance
Demand analysis – Utility Analysis, Indifference Curve, Elasticity & Forecasting Market Structures – Market Classification & Price Determination
National Income – Concept, Types and Measurement Inflation – Concept, Types and Measurement Business Ethics & CSR. Ethical Issues & Dilemma Corporate Governance Value Based Organisation

Unit – II

Organizational Behavior – Significance & Theories
Individual Behaviour – Personality, Perception, Values, Attitude, Learning and Motivation
Group Behaviour – Team Building, Leadership, Group Dynamics Interpersonal Behaviour & Transactional Analysis, Organizational Culture & Climate
Work Force Diversity & Cross Culture Organisational Behaviour Emotions and Stress Management
Organisational Justice and Whistle Blowing
Human Resource Management – Concept, Perspectives, Influences and Recent Trends
Human Resource Planning, Recruitment and Selection, Induction, Training and Development
Job Analysis, Job Evaluation and Compensation Management

Unit – III

Strategic Role of Human Resource Management Competency Mapping & Balanced Scoreboard Career Planning and Development
Performance Management and Appraisal
Organization Development, Change & OD Interventions Talent Management & Skill Development
Employee Engagement & Work Life Balance
Industrial Relations: Disputes & Grievance Management, Labour Welfare and Social Security
Trade Union & Collective Bargaining
International Human Resource Management – HR Challenge of International Business
Green HRM

Unit– IV

Accounting Principles and Standards, Preparation of Financial Statements
Financial Statement Analysis – Ratio Analysis, Funds Flow and Cash Flow Analysis, DuPont Analysis

Preparation of Cost Sheet, Marginal Costing, Cost Volume Profit Analysis Standard Costing & Variance Analysis
Financial Management, Concept & Functions

Capital Structure – Theories, Cost of Capital, Sources and Finance Budgeting and Budgetary Control, Types and Process, Zero base Budgeting
Leverages – Operating, Financial and Combined Leverages, EBIT–EPS Analysis, Financial Breakeven Point & Indifference Level.

Unit –V

Value & Returns – Time Preference for Money, Valuation of Bonds and Shares, Risk and Returns;
Capital Budgeting – Nature of Investment, Evaluation, Comparison of Methods; Risk and Uncertainly Analysis
Dividend – Theories and Determination
Mergers and Acquisition – Corporate Restructuring, Value Creation, Merger Negotiations, Leveraged Buyouts, Takeover
Portfolio Management – CAPM, APT
Derivatives – Options, Option Payoffs, Option Pricing, Forward Contracts & Future Contracts
Working Capital Management – Determinants, Cash, Inventory, Receivables and Payables Management, Factoring
International Financial Management, Foreign exchange market

Unit - VI

Strategic Management – Concept, Process, Decision & Types
Strategic Analysis – External Analysis, PEST, Porter's Approach to industry analysis, Internal Analysis – Resource Based Approach, Value Chain Analysis
Strategy Formulation – SWOT Analysis, Corporate Strategy – Growth, Stability, Retrenchment, Integration and Diversification, Business Portfolio Analysis - BCG, GE Business Model, Ansoff's Product Market Growth Matrix
Strategy Implementation – Challenges of Change, Developing Programs Mckinsey 7s Framework
Marketing – Concept, Orientation, Trends and Tasks, Customer Value and Satisfaction
Market Segmentation, Positioning and Targeting
Product and Pricing Decision – Product Mix, Product Life Cycle, New Product development, Pricing – Types and Strategies
Place and promotion decision – Marketing channels and value networks, VMS, IMC, Advertising and Sales promotion

Unit –VII

Consumer and Industrial Buying Behaviour: Theories and Models of Consumer Behaviour
Brand Management – Role of Brands, Brand Equity, Equity Models, Developing a Branding Strategy; Brand Name Decisions, Brand Extensions and Loyalty
Logistics and Supply Chain Management, Drivers, Value creation, Supply Chain Design, Designing and Managing Sales Force, Personal Selling
Service Marketing – Managing Service Quality and Brands, Marketing Strategies of Service Firms
Customer Relationship Marketing – Relationship Building, Strategies, Values and Process
Retail Marketing – Recent Trends in India, Types of Retail Outlets.
Emerging Trends in Marketing – Concept of e-Marketing, Direct Marketing, Digital Marketing and Green Marketing

International Marketing – Entry Mode Decisions, Planning Marketing Mix for International Markets

Unit –VIII

Statistics for Management: Concept, Measures Of Central Tendency and Dispersion, Probability Distribution – Binominal, Poison, Normal and Exponential
Data Collection & Questionnaire Design Sampling – Concept, Process and Techniques
Hypothesis Testing – Procedure; T, Z, F, Chi-square tests Correlation and Regression Analysis
Operations Management – Role and Scope
Facility Location and Layout – Site Selection and Analysis, Layout – Design and Process
Enterprise Resource Planning – ERP Modules, ERP implementation Scheduling; Loading, Sequencing and Monitoring
Quality Management and Statistical Quality Control, Quality Circles, Total Quality Management – KAIZEN, Benchmarking, Six Sigma; ISO 9000 Series Standards
Operation Research – Transportation, Queuing Decision Theory, PERT / CPM

Unit –IX

International Business – Managing Business in Globalization Era; Theories of International Trade; Balance of payment
Foreign Direct Investment – Benefits and Costs
Multilateral regulation of Trade and Investment under WTO International Trade Procedures and Documentation; EXIM Policies Role of International Financial Institutions – IMF and World Bank
Information Technology – Use of Computers in Management Applications; MIS, DSS
Artificial Intelligence and Big Data
Data Warehousing, Data Mining and Knowledge Management – Concepts Managing Technological Change

Unit – X

Entrepreneurship Development – Concept, Types, Theories and Process, Developing Entrepreneurial Competencies
Intrapreneurship – Concept and Process
Women Entrepreneurship and Rural Entrepreneurship
Innovations in Business – Types of Innovations, Creating and Identifying Opportunities, Screening of Business Ideas
Business Plan and Feasibility Analysis – Concept and Process of Technical, Market and Financial Analysis
Micro and Small Scale Industries in India; Role of Government in Promoting SSI Sickness in Small Industries – Reasons and Rehabilitation
Institutional Finance to Small Industries – Financial Institutions, Commercial Banks, Cooperative Banks, Micro Finance.

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I. Mathematical Methods of Physics:

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.
Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using RungeKutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

II. Classical Mechanics:

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and mass–energy equivalence.
Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

III. Electromagnetic Theory:

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors.
Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

IV. Quantum Mechanics:

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigen value problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.
Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

V. Thermodynamic and Statistical Physics:

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.
First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

VI. Electronics and Experimental Methods:

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.
Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

VII. Atomic & Molecular Physics:

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation.

Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. Condensed Matter Physics:

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. Nuclear and Particle Physics:

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

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SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT OF ASSISTANT PROFESSOR IN PRODUCTION ENGINEERING DEPARTMENT

Section 1: General Engineering

Engineering Materials: Structure and properties correlation; engineering materials (metals, ceramics, polymers and composites) – properties and applications; stress-strain behavior of metals and alloys; iron-carbon phase diagram, heat treatment of metals and alloys, its influence on mechanical properties.

Applied Mechanics: Engineering mechanics – equivalent force systems, free body concepts, equations of equilibrium; trusses; strength of materials – stress, strain and their relationship; failure theories, Mohr's circle(stress), deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, cams and followers; governors and fly wheels; design of bolted, riveted and welded joints; interference/shrink fit joints; design of shafts, keys, spur gears, belt drives, brakes and clutches; pressure vessels.

Thermal and Fluids Engineering: Fluid mechanics – fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum, capillary action, contact angle and wetting; thermodynamics – zeroth, first and second law of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; air standard cycles; heat transfer – basic applications of conduction, convection and radiation.

Section 2: Manufacturing Processes I

Casting: types of casting processes and applications; patterns – types and materials; allowances; moulds and cores – materials, making, and testing; casting of solidification and microstructure development; design of gating and riser; origin of defects.

Metal Forming: Stress-strain relations in elastic and plastic deformation; concept of flow stress; hot and cold working – forging, rolling, extrusion and wire drawing; sheet metal working processes – blanking, bending and deep drawing; ideal work and slab analysis; origin of metal working defects.

Joining of materials: Principles of fusion welding processes (manual metal arc, MIG, TIG, plasma arc, submerged arc welding processes)–different heat sources (flame, arc, resistive, laser, electron beam), and heat transfer and associated losses, flux application, feeding of filler

rod; Principles of solid state welding processes (friction, explosive welding, ultrasonic welding processes); Principles of adhesive, brazing and soldering processes; Origins of welding defects.

Powder processing: Production of metal/ceramic powders, compaction and sintering of metals and ceramic powders.

Polymers and Composites: Plastic processing – injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Section 3: Manufacturing Processes II

Machine Tools and Machining: Basic machine tools like centre lathe, milling machine, and drilling machine – construction and kinematics; machining processes - turning, taper turning, thread cutting, drilling, boring, milling, gear cutting, thread production, grinding; geometry of single point cutting tools, chip formation, cutting forces, specific cutting energy and power requirements, Merchant's analysis; basis ofselection of machining parameters; tool materials, tool wear and tool life, economics of machining, thermal aspects of machining, cutting fluids, machinability; Jigs and fixtures – principles, applications, and design

Non-traditional Manufacturing: Principles, applications, effect of process parameters on MRR and product quality of non-traditional machining processes – USM, AJM, WJM, AWJM, EDM and Wire cut EDM, LBM, EBM, PAM, CHM, ECM.

Computer Integrated Manufacturing: Basic concepts of CAD – geometric modeling, CAM – CNC and robotics – configurations, drives and controls, Group Technology and its applications – CAPP, cellular manufacturing and FMS.

Section 4: Quality and Reliability

Metrology and Inspection: Limits, fits, and tolerances, gauge design, interchangeability, selective assembly; linear, angular, and form measurements(straightness, squareness, flatness, roundness, and cylindricity) by mechanical and optical methods; inspection of screw threads and gears; surface finish measurement by contact and non-contact methods; tolerance analysis in manufacturing and assembly.

Quality management: Quality – concept and costs; quality assurance; statistical quality control, acceptance sampling, zero defects, six sigma; total quality management; ISO 9000.

Reliability and Maintenance: Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; determination of system reliability; preventive maintenance and replacement.

Section 5: Industrial Engineering

Product Design and Development: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives.

Work System Design: Taylor's scientific management, Gilbreths'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.
Facility 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.

Section 6: Operations research and Operations management

Operation Research: Linear programming – problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; Markovian queuing models; dynamic programming; simulation – manufacturing applications.

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

Production control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; routing, scheduling and priority dispatching; Push and pull production systems, concept of JIT manufacturing system; Logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic inventory models, quantity discount; perpetual and periodic inventory control systems.

Project management – PERT and CPM.