DEPARTMENT OF CIVIL ENGINEERING

ALIGARH MUSLIM UNIVERSITY, ALIGARH

SYLLABUS OF GEOTECHNICAL ENGINEERING FOR PHD ENTRANCE TEST 2018-19

SECTION - B

Soil Engineering: Different types of soils and their geotechnical properties, Behavior of different soils under moisture and loading conditions, Determination of geotechnical properties through field tests. In-situ tests, selection of suitable in-situ test, Instruments and their applications, Interpretation and analysis of results. Sampling methods and equipment for laboratory experiments, handling, preservation and transportation of samples, sample preparation, laboratory tests for site characterization. Concepts and importance of site characterization, methods of site characterization based on types of projects, comparison of lab and in-situ test results.

Foundation Design-I: Foundation failures (general, shear, punching, large settlements), Bearing Capacity equations, bearing capacity factors, factor of safety, bearing capacity of foundation: on layered soil, on or near slope, with eccentric loading, with inclined loading, with uplift forces, bearing capacity correlations with field tests (SPT, CPT, DCPT, etc.), Bearing capacity from building codes. Foundation design based on settlement criteria, stresses induced on soil mass due to foundations, settlement computations (Immediate, Primary settlement), layered soils, structures on fills, tolerable settlements, differential settlement, Building code recommendations. Types of shallow footing, factors affecting foundation design, design of spread footings for different loadings conditions (concentric, eccentric, shear, moment), design of rectangular and combined footings. Different types of piles, design methodology for piles, calculation of pile capacity, stresses in pile, analysis of pile group, pile load test, settlement of pile group, concept of negative skin friction, piles subjected to lateral loads.

Design of Earth Retaining Structures: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine and Coulomb theories, Active, passive and pressure at rest ; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice. Assumption and conditions, point of application of passive earth pressures. Types, material, method of construction, nature of forces acting, comparison of different earth pressure theories and application in retaining wall, stability analysis and design aspects, application of theory of elasticity in analysis of earth pressure distribution. Types, materials used in construction, free earth system, fixed earth system, selection of soil parameters, analysis and design of cantilever and anchored sheet pile walls, dead man and continuous anchor, diaphragm and bored pile walls. Earth pressure against bracings in cuts, heave of the bottom of cut in soft clays; reinforced earth retaining structures, design of earth embankments and slopes; arching and open cuts, recent advances in Earth retaining structures.

Advanced Ground Improvement Techniques: Compaction piles, dynamic compaction, vibro-floatation technique, controlled blasting for compaction. Principle of accelerated consolidation for clays, vertical drains, method of preloading, design of PVDs with vacuum-preloading systems, Electro-kinetic dewatering, design and construction methods. Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques and applications. Soil nailing, rock anchoring, micro-piles, design methods, construction techniques, case studies of ground improvement projects.

Rock Engineering: Formation of rocks, Physical properties, Classification of rocks and rock masses, Static Elastic constants of rock ; Rock Testing: Laboratory and Field tests ; Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock ; Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior; Strength/ Failure Criterion: Coulomb, Mohr, Griffith theory of brittle strength and other strength criteria. Stresses in rock near underground openings; Rock tunneling, rock slope stability, bolting, blasting, grouting and rock foundation design. Instrumentation in tunnels, Rock support and reinforcement

Foundation Design-II: Analysis and design of tension piles, laterally loaded piles, partially embedded piles and poles. **S**tructural design of: piles, laterally loaded piles, pile groups, pile cap analysis, pile – raft system basic interactive analysis. Drilled Piers: Application, construction practices, Capacity analysis and settlement, practical considerations and design; Cellular Cofferdams: Types and applications, stability analysis, bearing capacity, settlement, and practical consideration and design. Expansive soils, collapsible soils, frosty conditions.

Geo-synthetic and Reinforced Soil-Structure: Historical Development – Types of Geosynthetics – Geotextiles – Geogrids- Geonets – Geomembranes – Geocomposites – Functions – Reinforcement – Separation – Filtration – Drainage – Barrier Functions. Manufacturing Methods of – Polyamide – Polyster – Polyethylene – Polypropylene – Poly Vinyl Chloride – Woven – Monofilament – Multifilament – Slit Filament – Non-Woven – Mechanically bonded- Chemically bonded – Thermally bonded. Physical properties : Mass per unit area – Thickness – Specific gravity; Hydraulic properties :Apparent open size – Permittivity – Transmissivity. Mechanical Properties : Uniaxial Tensile Strength – Burst and Puncture Strength – Soil Geosynthetic friction tests; Durability : Abrasion resistance – Ultraviolet resistance. Use of geosynthetics for filtration and drainage – Use of geosynthetics in roads – Use of renforced soil in Retaining walls – Improvement of bearing capacity – Geosynthetics in land fills.

Soil Dynamics: Elastic response of continua, wave equation, response of non-plastic and plastic soils under cyclic loading; stress- strain models(elastic, visco-elastic, nonlinear elastic, plasticity), introduction to liquefaction. Vibration of elementary systems; Degrees of freedom (SDOF and MDOF systems); equation of motion for SDOF system, types of vibrations, Earthquake excitation, Un-damped and damped free vibrations, torsional vibration, critical damping, decay of motion, un-damped and damped forced vibration, constant force and rotating mass oscillators, dynamic magnification factor, transmissibility ratio, non-harmonic, arbitrary, impact and other types of forced vibrations, Duhamel's integral, vibration isolation, vibration measuring instruments. Stresses in soil element, determination of dynamic soil properties, field tests, laboratory tests, stress-strain behavior of cyclically loaded soils, estimation of shear modulus, damping ratio ,linear, equivalent-linear and non-linear models, ranges and applications of dynamic soil tests, cyclic plate load test, liquefaction, Screening and estimation of liquefaction, simplified procedure for liquefaction estimation, factor of safety, cyclic stress ratio, cyclic resistance ratio, correlations with SPT, CPT, SASW test values. Dynamic earth pressures, force and displacement based analysis, pseudo-static and pseudo-dynamic analysis, guidelines of design codes, dynamic analyses of various geotechnical structures like retaining wall, soil slope, railway subgrade and ballast using MSD model.

Advanced Techniques in Geotechnical Engineering: Shell foundations, special construction problems, pile driving and well sinking, pre-stressed ground anchors, diaphragm walls, bored pile walls, soil nailing, gabions, crib wall, retaining walls with relieving shelves, piled raft foundation, granular pile anchor in swelling soils, cantilever footing, Simplex pile, under reamed pile construction, half bulb, V-piles. Drainage of soil and dewatering of foundations, controlled yielding technique for reduction of lateral earth pressure, Vibro-compaction, Soilcrete, Soilfrac (Soil fracturing), static installation of piles – Pipe/Box jacking, vacuum consolidation, dynamic compaction, cathodic protection of marine foundations, role of drilling mud in geotechnical engineering, Terramesh for slope stabilization. Dynamic pile testing, Centrifugal testing of geotechnical models, Pressure meter testing, The flat dilatometer test, Piezocone test, Osterberg cell, Advances in geotechnical testing and monitoring. Geotechnical modern case studies. Basic rules for personal safety, Public safety and safety tips for workplace with special reference to electrical and fire safety, Safety of workers, machine and environment during various field operations of foundation excavations, pile driving, tunneling, quarrying and material handling, Environmental issues in geotechnical engineering, sources and type of ground, water and air contamination, Protection of environment from harmful effects of different construction activities, Utilization and contamination of large volume wastes.

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DEPARTMENT OF CIVIL ENGINEERING
ALIGARH MUSLIM UNIVERSITY, ALIGARH
SYLLABUS OF HYDRAULIC STRUCTURES FOR PHD ENTRANCE TEST 2018-19

SECTION – B

Design of Irrigation Works: Principle of design of hydraulic structures on permeable foundation, Mechanics of failure of hydraulic structures on permeable soil, Design of barrage. Design of silt excluder and silt ejector, Design of guide banks and spurs. Design of subcritical canal transitions: Hind's method, Vittal and Chiranjeevi's method of transition design, Design of supercritical transition. Design of head and cross regulators, Design of falls.

Reservoir Engineering: Types of reservoir, Site selection for a reservoir, Area -elevation curve, Capacity- elation curve, Various zones of reservoir, Reservoir Capacity estimation, Flow mass curve, Sequent Peak, Algorithm, Estimation of maintainable demand. Reservoir sedimentation, Mechanics of sedimentation, Estimation of silt load, Distribution of sediment in reservoir. Wind setup and waves in reservoir, Reservoir operation. Peak flood estimation: Empirical methods, Rational method, Flood frequency analysis, Gumbel's extreme value distribution, Log-Pearson type III distribution, Concept of risk reliability and safety factor for a reservoir. Concept of flood routing, Factors responsible for flood routing, Routing classification, Reservoir routing.

Fluvial Hydraulics: Sediment properties, incipient motion of sediment, competent velocity, lift concept, critical tractive force of cohesion less and cohesive materials, Regimes of flow, ripple and dune regimes, anti-dune regime, importance and prediction of regimes of flow. Resistance to flow and velocity distribution in alluvial streams, Bed load equations based on dimensional considerations and semi theoretical equations, suspended load, general considerations about sediment distribution equation, prediction of reference concentrations. Total load transport, microscopic and macroscopic methods based on a single size and fraction wise size calculations, Sediment samplers and sampling, bed load and suspended load sampling. Design of stable channels in alluvium: variables in channel design, general comments on regime and tractive force methods of channel design. Bed level variation in alluvial streams, local scour, degradation, aggradation, silting of reservoir, River models, Sediment flow through pipes.

Rigid Dam: Dam: types, characteristics, relative merits and demerits, site investigations and selections, foundation grouting, forces acting on dam, Gravity dams: stability requirements, modes of failure and factor of safety, elementary profile of gravity dam, methods of analysis, zoning of gravity dams, design criteria. Stress analysis in gravity dams, normal and shear stresses, principal stresses, internal stresses, galleries in dams, stress concentration around openings, joints in dams, construction of gravity dams, instrumentation in gravity dam. Arch Dam: General consideration, types and characteristics, Forces acting on Arch dams, Design criteria, Cylinder theory and elastic theory of design, Construction of arch dams. Buttress dam: Merits, Types and characteristics, Forces acting, design of deck, buttresses, Unit column theory, Construction of buttress dam.

Earth and Rock-fill Dams: Basic design aspects, Classification of embankment dams, Criteria for safe design, Free board, Upstream and downstream slope protection, cracking of earth dams, Hydraulic fracturing, Causes of cracking, Preventive and remedial measures. Seepage theory, Determination of free surface and seepage discharge through dams for isotropic as well as anisotropic soils. Flow net for earth dam under steady seepage condition, various methods of seepage control, Selection of core materials, Drainage of embankments, Design of transition filters, Use of geo-textiles. General characteristics of Rock fill dams, Materials for rock fill dams, testing of rock-fill material, Design of dam section, Types of membrane, Rock fill placement, Deformation of rock fill dams, Flow through and over rock-fill dam, Concrete faced rock-fill dam. Stability analysis, Method of slices, Graphical method, Foundation exploration for Earth and Rock fill dams, Treatment of foundations, Quality control and instrumentation, River diversion during construction of dam.

Advanced Engineering Hydrology: Design Storms, Probable Maximum Precipitation, Spillway design flood, Standard project flood, Probable maximum flood. Guide lines for selecting design flood. Random Variable and Probability, Statistical Analysis of random variables, Probability distribution function, Frequency analysis, Regression analysis, Risk and Reliability analysis of Hydraulic Engineering System. At site flood Frequency analysis, annual and partial duration series, Regional Flood Frequency Analysis, Reservoir and channel flood Routing. Hydrograph analysis, Separation of Stream Flow Components, Unit Hydrograph, Synthetic Unit Hydrograph, Instantaneous unit hydrograph, Dimensionless unit hydrograph, Distribution graph.

Hydro-Power Structures: Sources of energy, role of hydropower in a power system, Estimation of power potential of stream, Storage and Pondage studies, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power and secondary power. Hydro-power plants, Elements, general arrangement of various Hydel plants such as run off river plants, valley dam plants, diversion canal plants, high head diversion plants, pumped storage power plants etc., Efficiency and Installed capacity of plants. Intakes, Types, losses, air entrainment, air vent, power channels, fore-bay, Tunnel, Penstocks, General classification, design criteria, economical diameter, anchor blocks, valves, bends and manifolds, Surge tanks, Classification, Analysis of simple surge, Water hammer. Selection, setting and cavitation in turbines, Draft tubes, classification, Dimensioning and laying of power houses, Safety measures during construction of power plants.

Advanced Hydraulics: Gradually Varied Flow: Computation of GVF profiles using analytical and numerical methods. Unsteady Flow: St. Venant's equations and their solution, hydraulic flood routing, Dam break problem. Rapidly Varied flow: thin plate weirs, special types of weirs such as linear proportional weir, Labyrinth weir, Piano key weir. Hydraulic jump in non-rectangular channels. Spatially Varied Flow: Side channel spillway, side weir, De Marchi equation, uniformly discharging side weir, Trench weir. Air-entrainment, Diffusion, Dispersion and their governing equations, some classical solutions of diffusion equations, Dispersion and diffusion coefficients.

Spillways and Energy Dissipators: Spillways: Introduction, Ogee spillway, Side channel spillway, Chute spillway, Shaft spillway, Siphon spillway: volute siphon and saddle siphon, Location of spillway. Design of Spillways: Introduction, Stability, Performance, Design of upstream profile of spillway, Design of downstream profile of spillway. Energy Dissipaters: Energy dissipation below overflow spillways, Hydraulic jump, Jump height curve and Tail water curve, Stilling basins, Chute blocks, Sills and dented sills, Baffle piers, U.S.B.R. Basins. Intake works and Gates: Introduction, Sluiceways or dam outlet, Hydraulics of outlet works, River intakes: Simple submerged intakes, Intake towers, wet intake and dry intake, Trash Racks. Dropping shutters, stop logs and needles, Vertical lift gates, Radial or tainter gates, Drum gate, Intake gates and valves.

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DEPARTMENT OF CIVIL ENGINEERING
ALIGARH MUSLIM UNIVERSITY, ALIGARH
SYLLABUS OF SRUCTURAL ENGINEERING FOR PHD ENTRANCE TEST 2018-19

SECTION – B

Theory of Elasticity and Plasticity: Theory of stresses, infinitesimal and finite strain, strain-displacement relationships, elastic constants. Stress and displacements functions, plane problems in Cartesian and polar co-ordinates. Elements of plasticity, failure and yield criteria, flow rule. Velocity field, plastic stress-strain relationships, incremental plasticity

Plates and Shells: Background and basic concepts; Basic concepts, governing equations and boundary conditions of plates. Solution of Plates; Solution of rectangular and circular plates by classical methods: Navier's and Levy's methods. Membrane theory of cylindrical shells; Introduction, types of shell surface, classification, basic concepts, equations of equilibrium, application of Fourier series for membrane stresses, numerical solutions, limitations of membrane theory. Bending theory of cylindrical shells; Flugge's differential equation, Donnell's theory, D-K-J characteristic equation, Schorer's theory, shell analysis using tables, design consideration.

Advanced Structural Analysis: Introduction to Matrix methods in skeletal structural analysis: force and displacement methods. Application of force method to plane and space frames problems. Application of displacement method to plane and space frames problems. Analysis of Frames, Organization of computation, programming considerations. Non-linear analysis due to plasticity in frames.

Advanced Concrete Design: Limit state design: Basic concepts and philosophies, design of RC members in flexure, shear and torsion, members subjected to combined stresses, slender column, safety and serviceability, control of cracks and deflections, design of RC framed structures with ductile detailing. Yield line analysis of slabs, yield line mechanism, equilibrium and virtual work methods, Hillerberg's strip method. Pre-stressed Concrete, Design of pre-stressed members for bending, shear, torsion and bond, End blocks. Pre-stressed continuous beams and frames, slab and grid floor, tension and compression members, circular pre-stressing, pipes, tanks and special structures.

Finite Element Analysis: Finite element method and other classical methods, historical background, advantages & disadvantages, finite element modeling – discretization, nodes, elements types and shapes. Basic equations in elasticity – stress and strain vectors, Hooke's law, strain-displacement relationship, equilibrium equations, generalized compatibility equations. Finite element analysis of one dimensional problem. Generation of stiffness matrix by displacement and energy method, energy and variational approaches (Rayleigh-Ritz method), numerical solutions. Iso-parametric elements and shape functions. Co-ordinate systems, Element shapes, Strain displacement matrix, Higher order elements: 1D, 2D and 3D. Finite element analysis of two dimensional problems, Symmetry, Plane stress and plane strain problems, bending of thin plates, Introduction to nonlinear FE analysis.

Structural Dynamics: Types of Vibration and Ground motions, Undammed and Damped Single Degree of Freedom System, Response of SDOF System to Harmonic Loading. Response to General Dynamic and Impulsive Loading, Duhamel's Integration, Fourier analysis and Response in the Frequency Domain. Free Vibration of Lumped Multi Degree of Freedom System. Approximate Methods For Obtaining Natural Frequencies and Mode Shapes. Frequency Domain Analysis of Lumped Multi Degree of Freedom System Using Normal Mode Theory, Time Domain Analysis Using Numerical Integration Scheme. Principle of Virtual Work, Rayleigh's and Modified Rayleigh's Method, Dynamic Analysis of Systems with Distributed Properties.

Advanced Steel Design: Loads, classification and design procedures, plate girder bridges and truss girder bridges. Steel Chimneys; Analysis and design of steel chimneys and elevated steel water tanks. Towers; Analysis and design of transmission line and microwave towers. Tubular Sections; Structural behavior of tubular sections, analysis and design of tubular sections, brittle fracture and fatigue in steel structures, plastic design of steel structure.

Construction Planning and Management: Overview of construction, development and organization of projects, Construction organization structure, Construction finance management, scope of financial management, working capital management, capital investment decision. Construction materials and Equipment management; Economy in material management, inventory management and control, purchase and store management, specialized buying and vendors management. Equipment performance characteristics, selection, planning and matching of construction equipment, equipment management. Safety & Environment at Work Place and Human resource management; Basic Rules for personal Safety, Public Safety and safety of equipment at construction sites, Safety management in construction Industry, Environment at construction sites, , construction human resources management; introduction to human resource management, labor legislation, industrial relations, women in construction, Environment issues in construction.

Construction contract management; Legal aspects of contract, contract procedures and document, important contract clauses, quality control during construction; Construction accounting; nature and role of accounting, accounting process and book of accounts, accounting conventions and final account, inventory valuation and depreciation.

Earthquake Resistant Design of Structures: Characteristics of earthquakes: Earthquake terminology, magnitude, intensity, measurement of ground motion, frequency-magnitude relationship, liquefaction. Strong ground motion: Acceleration time histories, parameters (peak ground acceleration/velocity/displacement), response spectrum, site effects. Earthquake analysis of structures: Idealization of structures, response spectrum analysis, equivalent force concepts, torsionally coupled systems. Concepts of earthquake resistant design: objectives, ductility, ductility reduction factor, over-strength, response reduction factor, design response spectrum, lateral stiffness, building configuration, base isolation, concept of structural control. Building codes: Performance of buildings in past earthquakes, historical perspective of code development, Indian code (IS: 1893), provisions for buildings, Retrofitting and strengthening of structures (IS: l3935) Detailing for reinforced concrete and masonry buildings, provisions of IS: 13920, IS: 4326.

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DEPARTMENT OF CIVIL ENGINEERING
ALIGARH MUSLIM UNIVERSITY, ALIGARH
SYLLABUS OF ENVIRONMENTAL ENGINEERING FOR PHD ENTRANCE TEST 2018-19

SECTION – B

Environmental Chemistry: Basic Principles, Chemical Kinetics, Reaction Rates, Oxidation-Reduction reactions, Redox Stoichiometry, Applications of redox Chemistry, Chemical Equilibria, Basic concepts from Equilibrium Chemistry, Solubility Product, Common Ion Effect, Solubility Equilibria, Precipitation-Dissolution, Acid-Base Equilibria, Strong and Weak Acids, Carbonate System, pH, Buffers and Buffer Intensity, Complex Formation, Log Concentration Diagrams, Metal Hydroxide Precipitation, Metal Speciation, Water stabilization, Langlier Saturation Index, Cadwell-Lawrence Diagram, Organic Chemistry, Aquatic chemistry, Atmospheric chemistry, Toxic Compounds, Organic Solvents, Pesticides, Dioxins, PCBs and PAHs, Surfactants, Laboratory practice for determination of ions and solids.

Ecology and Environmental Microbiology: Principles of ecology, Ecosystems, Biotic and Abiotic Components, Trophic Levels, Material and Energy Flow in Ecosystems, Nutrient Cycles, Food chain and Bio-magnification, Ecology of Population. Microorganisms in Wastewater Treatment, Microbiological Concepts- cells, classification and characteristics of living organisms, Characterisation Techniques, Microbial Metabolism, Basic metabolic models, Chemistry of carbohydrates, proteins, fats and lipids, Population Dynamics. Microbial Growth Kinetics, Role of Microorganisms in biogeochemical cycles, Microbiological Analysis, Chemical Composition of Biomass, Waterborne Pathogens, Bacteria, Fungi, Yeast, Algae, Protozoa, Enzymes, Microorganisms as Food, Water and Wastewater Treatment Microbiology, Microorganisms and Air Pollution. Microbiology of Anaerobic Digesters, Sludge Microbiology, Stress on the Microbial Community, Biochemical reactions, Microbiology of aerobic and anaerobic processes, Biochemical pathways, Application of microbiology for pollution control and environmental engineering, Laboratory Practice.

Physical & Chemical Processes: Water Quality, Gas Transfer-Gas Liquid Equilibrium, Two Film Theory, Kinetics, Oxygen Transfer, Aeration Systems, Ammonia Stripping, Coagulation-Colloids, Diffuse Layer Theory, Particle Stability, Mechanisms of Destabilization. Flocculation-Velocity Gradient, Kinetics, Baffled and Paddle Wheel Flocculation, Sedimentation-Discrete, Flocculent and Hindered Settling, Ideal Horizontal Flow Reactor, Up flow Reactor, Design Parameters, Tube Settlers, Granular Media Filtration-Rapid and Slow Sand Filter, Particle Removal Mechanisms and Head Loss, Filter Run and Breakthrough, Constant and Declining Rate Filtration, Filter Backwashing, Dissolved Air Flotation-Design Considerations, Water Fluoridation, Iron and Manganese Removal, Chemical Precipitation-Lime-Soda Softening, Split Treatment, Ion Exchange-Materials and Reactions, Ion Selectivity, Ion Exchange Equilibrium, Regeneration, Disinfection-Kinetics of Disinfection, Disinfectant Types, Available Chlorine, , Membrane Separation Processes, Desalination.

Air Pollution and Control: Sources and classification of air pollutants; Classification, Sources and Effects of air pollutants, Sampling Methods and Measurements of Air Pollutants, Measurement and analyses of primary air pollutants SO2, NOx and SPM using high volume sampler, Ambient Air Quality Standards, Emission Standards. Meteorology and dispersion of pollutants; Basic Meteorology, Transport, Dispersion and Transformation of pollutants in Air, Adiabatic Lapse Rate, Atmospheric Stability, Dispersion of Pollutants, Air Pollution Dispersion Models, Point, Line and Area Source Models, Inversions, Plume Behaviour, Mixing Height, Plume Rise, Stack Emissions and Design. Particulate control methods; Air Pollution Control Techniques, Control of Particulate Matter, Theory and description of control devices and their applications, Equipment's and their Design, Selection of Control Equipment's, Engineering Control, Concepts of Gravity Settling Chamber, Cyclone, Fabric Filter, Electrostatic Precipitator. Gaseous and noise control methods; Control of Gaseous Pollutants-Oxides of Nitrogen and Sulphur, Sources and effects of noise pollution, Kinetics of noise, Measurement and control of noise pollution, Climate Change, Odour Removal, Atmospheric Chemistry, Photochemical Smog, Global Change-Greenhouse Effect and Global Warming, Ozone Layer Depletion, Acid Rain, Air Emissions from Wastewater Treatment Facilities and their Control.

Biological Processes I: Principles of Biological Treatment, Treatment Kinetics, Substrate Removal Efficiency, Reactor Profiles, Continuous Flow Reactors-Hydraulic and Performance Characteristics (Pulse and Step Input Response), Aerobic Systems-Aerobic Biological Treatment, Kinetics of Organics Removal, Substrate Utilization and Biomass, Growth, Monod's Kinetics, Estimation of Kinetic Parameters, Cell Yield, Sludge Settling, Nutrient Requirements, Activated Sludge Process Description and its Modifications, Process Design, Process Performance

Evaluation and Troubleshooting, Extended Aeration, Design of Aeration Systems, Design of Secondary Settlers, Sludge Bulking and Foaming, Biofilm Processes, Trickling Filter, Bio-towers, Substrate Removal Attached Growth System, Rotating Biological Contactors, Oxidation Ditches, Stabilization Ponds and Aerated Lagoons- Types and their Description, Design, Operation and Maintenance, Aerobic Digestion, Sequencing batch reactor and Process Design, Wetland Treatment Systems, Membrane Bioreactor, Moving Bed Biofilm Reactor. Biological Nutrient Removal, Nitrification and Denitrification- Process Kinetics, Treatment Plants for Nitrification and Denitrification, Anaerobic Ammonium Oxidation, Biological Removal of Toxic and Recalcitrant Organic Compounds, Biological Phosphorus Removal, Treatment Plants for Phosphorus Removal.

Industrial Wastewater Treatment: Industrial Waste Survey, Waste Characterization, Treated Effluent Disposal Standards, Effects of Industrial Wastewater on Receiving Water Bodies and Municipal Sewage Treatment Plants, Wastewater Sampling techniques, Flow Measurement, Waste Management Strategies and Programs, Waste Reduction-Volume and Strength Reduction, Flow Equalization and Proportioning. pH control and Neutralization, Zero Discharge Concepts, Removal of Specific Pollutants in Industrial Effluents, Oil and Grease Removal, Removal of Inorganic and Organic Constituents, Overview of Wastewater Treatment, Processes, Removal of Cyanides and Chromium. Characteristics and Treatment of Various Industrial Effluents, Pollution Control and Case Studies in Selected, Process Industries-Chlor Alkali Industry, Electroplating Industry, Fertilizer and Tannery, Identification of treatment flow sheets and wastewater treatment for selected industries- Sugar Industry, Distillery, Brewery, Paper and Pulp, Dairy, Slaughterhouse and Petroleum Refinery.

Wastewater Treatment Plant - Design and Operation: Wastewater treatment flow sheets, Bar Screens- Design and Hydraulics, Fine Screens and Micro screens, Grit Chamber, Proportional Weir, Sedimentation Tanks- Inlet and Outlet Design, Flow Distribution, Biological Waste Treatment- Activated Sludge Process, Extended Aeration, Bio-filter, UASB Reactor, Fluidized/Expanded Bed System, Ponds and Lagoon Design, Design of Nitrogen and Phosphorus Removal System, Disinfection Systems, Sludge Drying Beds.

Biological Processes II: Bioreactor Engineering, Anaerobic Treatment Fundamentals, Applications, Process Monitoring and Control, Kinetics of Anaerobic Treatment, Application of Anaerobic Digestion to Waste Treatment, Conversion, Environmental Factors**.** Anaerobic Treatment Processes, pH value and Stability in Anaerobic Digester, Suspended Growth and Fixed Film Processes, Anaerobic Process Design**,** Anaerobic Contact Process, Fixed Film Anaerobic Reactor Design, UASB Process Design for various types of Wastewaters, Anaerobic Lagoons**,** Anaerobic Sludge Digestion, Post Treatment of Effluents from Anaerobic Reactors, Refractory Organics, Biogas Utilization, Selected case studies.

Water Treatment Plant-Design and Operation: Treatment flow sheets, Mass balance calculations, Treatment Plant Hydraulics, Head Loss Types and Calculations, Manifold Hydraulics, Flow measurement. Population Forecasting, Water Use and Demand, Intake Facilities, Design of Aeration Systems. Design of Chemical Mixing, Flocculation Process Design, Filter Design, Ion Exchange Process and Equipment Design. Sedimentation Tank Design, Membrane Unit Design, Chemical Precipitation, Disinfection and Sludge Handling.

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