

Technical Subject (Civil Engineering - Sanitary)

Section (A)

1. Hydraulics and Hydrology

1.1 Hydraulics

- 1.1.1 Flow in pipes, Flow regimes, Bernoulli's equation, Darcy-Weisbach equation, Hydraulic losses in fittings and transitions in pipes, Equivalent lengths, Flow coefficients, Flow measurement in pipelines, Specific energy, Energy grade line, Hydraulic grade line, Location of critical flow points, Significance of Reynold's number and Froude number, Momentum functions, Non-uniform flow, Transitions, Lateral inflows, Lateral outflows
- 1.1.2 Open channel hydraulics (Chezy's equation, Manning's equation, Best hydraulic cross-sections, Controls in open channel flow)
- 1.1.3 Steady and unsteady flow
- 1.1.4 Water hammer, surge analysis, surge protection measures
- 1.1.5 Hydraulic jumps
- 1.1.6 Mechanics of sediment transport
- 1.1.7 Pressure equations

1.2 Hydrology

- 1.2.1 Elements of hydrologic cycle (Evaporation, Transpiration, Evapotranspiration, Condensation)
- 1.2.2 Measurement of precipitation and snow, Effective depth of precipitation, Events during precipitation, Surface runoff and infiltration
- 1.2.3 Stream hydrograph (base flow recessions, Storm hydrograph, Gaining and losing streams), Rainfall-Runoff relationship, Flow duration curve and Measurement of stream flow
- 1.2.4 Occurrence and types of surface and ground water
- 1.2.5 Surface and ground water movement
- 1.2.6 Flooding and inundation
- 1.2.7 Estimation of drainage discharge and design
- 1.2.8 River and bank protection design
- 1.2.9 Ground water recharge

Section (B)

2. Water Supply

2.1 Drinking Water

- 2.1.1 General overview of water resources in Nepal
- 2.1.2 Present status of water supply and sanitation in Nepal

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- 2.1.3 Current issues and challenges of water supply in rural and urban area
- 2.1.4 Sources and watershed management
- 2.1.5 Design principles and guidelines of water supply system
- 2.1.6 Pipe, fittings and appurtenance
- 2.1.7 Principles related to unit operations and processes: Aeration; Flocculation and coagulation; Sedimentation process (Type I, II, III & IV); Filtration Process: Slow sand filtration/Rapid filtration/Pressure filtration/ Ultra filtration/ Reverse osmosis; Disinfection process; Sludge handling and disposal; Sludge stream - Solid-liquid separation

2.2 Design and Treatment

2.2.1 Water Supply System

- 2.2.1.1 Pollutants (sources, types and effects), water demand and quantity, estimation of future population, design period
- 2.2.1.2 Design of intake structures for rural and urban water supply system (dams, weirs with essential components, impounding reservoirs, infiltration galleries, infiltration fields, sump wells, spring intakes and tower intake)
- 2.2.1.3 Safety of intakes against sliding, overturning and overtopping
- 2.2.1.4 Design of rain water collection for domestic use and harvesting for other purposes including ground water recharge
- 2.2.1.5 Pipeline design: design criteria, design of transmission and distribution system, network analysis, District Metering Area (DMA) - closed and dead-end systems
- 2.2.1.6 Reservoirs: types, size determination, design and management of multiple reservoir systems (hydraulic and operational control)
- 2.2.1.7 Instrumentation, control and automation (SCADA, PLC, IOT)
- 2.2.1.8 Design considerations for climate resilient water supply system
- 2.2.1.9 Design of pumping water supply system, selection of pumps and pump capacity
- 2.2.1.10 Design of surge protection

2.2.2 Drinking Water Treatment Facility

- 2.2.2.1 Design of pre-treatment facility: Intake, Bar Screen, Grit Chamber etc.
- 2.2.2.2 Design of treatment facilities: Sedimentation, Coagulation, Flocculation, Softening, Filtration systems (slow, rapid and pressure), Neutralization and Disinfection
- 2.2.2.3 Advanced treatment: Absorption by activated carbon, ion exchange, multimedia filtration, ultra-filtration, reverse osmosis, Straw, Disc & Nano filtrations, ozonation, ultra violet disinfection, demineralization/remineralization, new development in water treatment operation like compact modules

2.3 Management and Other related aspects

- 2.3.1 Estimation and management of Non-Revenue Water (NRW), Water balance model development, Active leak detection mechanism, Pressure management
- 2.3.2 Business plan of a water system: Operation and maintenance including preparation of manual, legal and management aspects, institutional development
- 2.3.3 Tariff structure, tariff rates and affordability, System cost recovery, Life cycle costing (CapEx, OpEx, CapManEx, Direct Support and CapEmEx)
- 2.3.4 Vulnerability risk assessment (VRA)
- 2.3.5 Benchmarking of water services and utility
- 2.3.6 Education and training

2.4 Ground Water Development

2.4.1 Ground Water Flow

- 2.4.1.1 Aquifer types and properties (Porosity, Specific yield, Hydraulic conductivity, Permeability, Water-Table and Potentiometric Surface maps, Gradient of potentiometric surface)
- 2.4.1.2 Ground water occurrences, Principles of ground water flow, Equations of ground water flow (Confined & Unconfined), Estimating aquifer transmissivity and specific capacity, Aquifer test designs, Chemical characteristics and properties of ground water
- 2.4.1.3 Geophysical Investigations (Electrical Resistivity, Electromagnetic Conductivity, Seismic Methods, Ground-Penetrating Radar and Magnetometer Surveys, Gravity and Aeromagnetic Methods)
- 2.4.1.4 Ground water exploration and methods of ground water withdrawal

2.4.2 Design of Deep Tube well

- 2.4.2.1 Tube well design
- 2.4.2.2 Drilling methods for tube well
- 2.4.2.3 Well logging
- 2.4.2.4 Pumping test, pump design and selection
- 2.4.2.5 Well development
- 2.4.2.6 Well sealing

2.4.3 Ground Water Quality

- 2.4.3.1 Groundwater contamination (Septic tanks and Cesspools, Landfills, Chemical spills and leaking underground tanks, mining)

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- 2.4.3.2 Ground water treatment (aerator, iron removal plant, lime removal) requirement based on ground water quality
- 2.4.3.3 Disinfecting wells and piping
- 2.4.3.4 Maintaining well yield
- 2.4.3.5 Sanitary protection for ground water supplies
- 2.4.3.6 Conservation and utility of ground water

2.5 Water Quality Issues

- 2.5.1 Introduction – Water resources and ecosystem, water cycle, fresh water and competitive use of water
- 2.5.2 Water pollution: Types and sources of water pollution, point and non-point pollution sources, effects of pollution (river, lake and reservoir)
- 2.5.3 Water quality and standards for various uses of water
- 2.5.4 Testing methods and procedures for water quality parameters
- 2.5.5 National drinking water quality standard
- 2.5.6 Environmental quality modelling and management of water bodies

Section (C)

3. Wastewater

3.1 Wastewater Quality Issues

- 3.1.1 Sources and nature of municipal and industrial wastewater, effluent quality and standards and impact on aquatic environment, effluent and stream standards
- 3.1.2 Management: Strategies for water pollution control, water quality monitoring and surveillance

3.2 Principles and Design of Wastewater Treatment

3.2.1 Municipal Wastewater

- 3.2.1.1 Sources and nature of wastewater, wastewater characteristics
- 3.2.1.2 Estimation of quantity of sanitary sewage and storm water sewage collection systems, sewers design criteria
- 3.2.1.3 Design of sanitary, storm water and combined sewer systems
- 3.2.1.4 Sewer Appurtenances: Manholes/ drop manholes/ cascades, Gas vents, Intermediate holding tanks, Inverted siphons, House connections, Storm water inlets
- 3.2.1.5 Design of primary treatment: Bar screen, grit chamber
- 3.2.1.6 Physical treatment: Screen/ Grit chamber / Equalization/ Flootation / Mixing / Sedimentation/ Flocculation
- 3.2.1.7 Chemical Treatment: Neutralization, Chemical precipitation, Absorption, Ion exchange, Electrolysis, Disinfection
- 3.2.1.8 Biological Treatment: Aerobic and Anaerobic Process- Aerated lagoons, Activated sludge process, Moving Bed Biological Reactor (MBBR), Oxidation ditches, Community septic tanks,

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Anaerobic tanks, Facultative ponds, Maturation ponds, Sludge digestion, Sludge drying, Composting, Constructed wetland (planted treatment system for nutrient removal), Land application methods

3.2.1.9 Process, control and operational issues in activated sludge system (Sludge recycling, F: M ratio, Sludge bulking, Foaming in the treatment plant, Flow measurement facilities, etc.)

3.2.1.10 Sludge treatment: Drying, Dewatering, Filtration, Centrifugation, Aerobic and anaerobic digestion, Chemical conditioning (immobilization), composting and incineration

3.2.1.11 Reuse and recycle of wastewater

3.2.2 Industrial Wastewater

3.2.2.1 Introduction to nature and origin of industrial wastewater and their impacts on aquatic environment, flow characteristic, effluent and stream standards, wastewater treatment processes

3.2.2.2 Pre and primary treatment: Equalization, neutralization, sedimentation, oil and grease separation, filtration, Heavy metal recovery processes

3.2.2.3 Wastewater treatment techniques: Coagulation and precipitation, biological treatment (conventional activated sludge, Extended aeration process, MBBR, UASB), Absorption/ adsorption, Ion exchange, Precipitation, Chemical Oxidation Reduction

3.2.2.4 Tertiary treatment for major polluting industries (tannery, textile, pulp and paper, sugar etc.)

3.2.2.5 Sludge treatment, handling and disposal

3.2.2.6 Industrial wastewater characteristics

3.2.2.7 Concept of central effluent treatment plant – advantages and disadvantages

3.2.2.8 Design criteria for industrial wastewater system

3.3 Management and Other related aspects

3.3.1 Waste water management, Fecal sludge management and sanitation service chain

3.3.2 Tariff setting criteria and regulation of tariff

3.3.3 Function of WASH planning

3.3.4 Sewage pumping

3.3.5 Legal and management aspects

3.3.6 Education and training

3.3.7 Operation and maintenance

3.3.8 Financial aspects: Tariff structure, tariff rates and affordability, system cost recovery

Section (D)

4. Solid Waste Management

4.1 Nature and Types Solid Waste

4.1.1 Solid waste management

4.1.2 Types of solid waste: Organic and inorganic, Recyclable and non-recyclable, inert waste, metals and glass, leather and cloths

4.1.3 Characteristics of solid waste: Weight, volume, specific weight, calorific value, moisture content

4.2 Solid Waste Collection and Treatment

4.2.1 Segregation of waste at source and storage

4.2.2 Collection and transportation

4.2.3 Material recovery facility

4.2.4 Treatment of waste

4.2.4.1 Organic - Composting (aerobic and anaerobic design), Waste to energy (biogas production and its design with wet and dry scrubbers for gas purification, reuse of the sludge), Manufacturing of RDF, Safe incineration without emission of Dioxin and Furans, Pyrolysis and production of Methanol, biochar

4.2.4.2 Inorganic: Recover and sell, Reuse, Repurpose, Recycle, Reduction (in volume through incineration with wet and dry scrubbers), Buy- Back Centers for plastics, metals, glass, leather, cloths

4.2.4.3 Final disposal: Sanitary landfill site (site selection, design of SLF, leachate treatment, gas venting/burning, O&M of SLF, environmental mitigation at SLF, grievance redress mechanism)

Section (E)

5. Regulatory and Environmental Framework

5.1 Regulation of Water Bodies and Systems

5.1.1 Quality of water in the natural water bodies

5.1.2 Effluent discharge into natural water bodies

5.1.3 Captive treatment plants, pre-treatment

5.1.4 Regulation of water (tanker, jar, bottle, piped systems) distribution

5.1.5 Quantity, quality, continuity, reliability regulation of water systems and the utility operators

5.1.6 Service level standards of water supply systems

5.1.7 Project bank

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- 5.1.8 Survey, data acquisition and compilation (N-WASH, Open source platform tools for data collection, WASH facility assessment tool, GLASS, MICS)
- 5.1.9 WASH in emergency- Preparedness & contingency planning, MIRA, PDNA, SPHERE minimum standard, mitigation & adaptation to disasters, Disaster risk management (DRM), WASH response, recovery and reconstruction

5.2 Environmental Health and Sanitation

- 5.2.1 Introduction: Fundamentals of epidemiology, infectious and non-infectious diseases, infectious disease transmission routes, organic and inorganic contaminants, and health and water quality
- 5.2.2 Human excreta and its characteristics, pollution caused by excreta, health aspects of water supply and sanitation
- 5.2.3 Pathogens: Excreted bacteria, helminthes and their control, diseases transmitted by arthropod vectors (mosquito, flies, cockroaches, bugs, lice)
- 5.2.4 Excreta treatment and disposal: Options, On site sanitation system (septic tank), Off site sanitation (Septage/ Fecal Sludge collection, FSTP, lagoon, waste stabilization ponds, anaerobic digestion)
- 5.2.5 Engineering and infectious diseases: Water related, excreta related, refuse related, housing related, diseases; reuse of wastes, watershed reservoir sanitation; engineering control of infectious disease
- 5.2.6 Climate change and its impact in WASH

5.3 Environmental and Social Assessment

- 5.3.1 Environmental screening
- 5.3.2 Concept of environmental assessment, impact identification and prediction (AHP and RPCT tools)
- 5.3.3 Brief Environmental Study (BES)
- 5.3.4 Initial environmental examination (IEE)
- 5.3.5 Environmental impact assessment (EIA), role of EIA, types of environmental impacts and EIA principles
- 5.3.6 Environmental management plan and its implementation, mitigation and monitoring

Section (F)

6. Service/Group/Sub-group related- Specific (Acts, Rules and Policies)

- 6.1 नेपाल खानेपानी संस्थान ऐन, २०४६
- 6.2 जलश्रोत ऐन, २०४९
- 6.3 जलश्रोत नियमावली, २०५०
- 6.4 खानेपानी व्यवस्थापन बोर्ड ऐन २०६३
- 6.5 खानेपानी तथा सरसफाई ऐन, २०८०

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- 6.6 राष्ट्रिय खानेपानी गुणस्तर मापदण्ड, २०७९
- 6.7 राष्ट्रिय खानेपानी, सरसफाई तथा स्वच्छता नीति, २०८०
- 6.8 राष्ट्रिय खानेपानी गुणस्तर कार्यान्वयन तथा अनुगमन निर्देशिका, २०७९
- 6.9 उपभोक्ता हित संरक्षण ऐन, २०७५
- 6.10 आवश्यक सेवा सञ्चालन ऐन, २०१४
- 6.11 खानेपानी तथा सरसफाई सम्बन्धी दीर्घकालिन अवधारणा

नोट : यस पत्रमा माथि उल्लिखित पाठ्यक्रमको खण्ड (F) बाहेकका प्रत्येक खण्ड (Section) बाट कम्तीमा एक प्रश्न समावेश हुने गरी लिखित परीक्षामा देहाय बमोजिमको संख्या र अङ्कभारका प्रश्नहरू सोधिने छ। तर खण्ड (F) बाट ५ अङ्कभारको छोटो उत्तर आउने एक प्रश्न र १० अङ्कभारको लामो उत्तर आउने एक प्रश्न गरी दुई प्रश्नहरू सोधिने छ।

पत्र	विषय	पूर्णाङ्क	उर्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या × अङ्क	समय
द्वितीय	Technical Subject	१००	४०	विषयगत (Subjective)	1 × 5 & 1 × 10 = 15 (Short & Long Answers) 3 × 15 = 45 (Critical Analysis) 2 × 20 = 40 (Problem Solving)	३ घण्टा

पाठ्यक्रम लागू मिति :- २०८१/०३/३० देखि