

## काठमाण्डौ उपत्यका खानेपानी लिमिटेड

प्राविधिक सेवा इलेक्ट्रो मेकानिकल समुह तह ७ ईन्जिनियर पदको

खुल्ला समावेशी तथा आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

१. लिखित परीक्षाको विषय, पूर्णाङ्क, प्रश्नसंख्या, अंकभार र समय निम्नानुसार हुनेछ ।

पत्र	विषय	पूर्णाङ्क	उतिर्णाङ्क	खण्ड	परीक्षा प्रणाली	प्रश्न संख्या	प्रति प्रश्न अंकभार	समय
प्रथम पत्र	सामान्य ज्ञान तथा सेवा सम्बन्धी सामान्य विषय	१००	४०	क) सामान्य ज्ञान र बौद्धिक परीक्षण	बस्तुगत बहु वैकल्पिक प्रश्न	१५	२	३ घण्टा
				(ख) बौद्धिक परीक्षण	बस्तुगत बहु वैकल्पिक प्रश्न	१०	२	
				(ग) सेवा सम्बन्धी सामान्य विषय	छोटो उत्तर आउने प्रश्न	१०	५	
द्वितीय पत्र	सेवा सम्बन्धी	१००	४०	विषयगत	लामो उत्तर आउने प्रश्न	१०	१०	३ घण्टा

२. द्वितीय चरण: अन्तर्वार्ताको योजना

विषय	पूर्णाङ्क	परीक्षा प्रणाली
व्यक्तिगत अन्तर्वार्ता	३०	मौखिक

३. प्रत्येक बस्तुगत प्रश्नमा चार वटा सम्भाव्य उत्तर दिइनेछ । जसमध्ये एउटा सही उत्तरमा (लोक सेवा आयोगले तोके बमोजिम) चिन्ह लगाउने वा लेख्नु पर्नेछ । प्रति गलत उत्तर वापत २० प्रतिशतका दरले अंक घटाइनेछ ।

४. प्रथम पत्र र द्वितीय पत्रको परीक्षा फरक फरक हुनेछ ।

५. दुवै पत्रको प्रत्येक खण्डको लागि फरक फरक उत्तरपुस्तिका प्रयोग गर्नुपर्नेछ ।

६. लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी वा दुवै हुन सक्नेछ ।

७. प्रश्नहरू यथासम्भव सबै इकाईबाट पर्नेगरी र नेपालको सन्दर्भमा सोधिने छन । लामो उत्तर दिनुपर्ने प्रश्न एकै वा खण्ड खण्ड गरी (दुई वा सो भन्दा बढी) सोध्न सकिनेछ । यस्तो प्रश्न एक भन्दा बढी इकाईबाट पर्ने गरी सोध्न सकिनेछ ।

८. यस पाठ्यक्रममा जेसुकै लेखिएको भएता पनि पाठ्यक्रममा परेका ऐन, नियमहरू परीक्षाको मिति भन्दा ३ महिना अगाडी (संशोधन भएका वा संशोधन भई हटाइएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झनु पर्दछ ।

९. परीक्षामा कालो मसी भएको कलम वा डटपेन मात्र प्रयोग गर्नुपर्नेछ ।

१०. पाठ्यक्रम लागु मिति २०७८ श्रावण १ गते देखि ।

## प्रथम पत्र: सामान्य ज्ञान र सामान्य बौद्धिक परीक्षण (१०० अंक )

### प्रथमपत्र

### खण्ड (क) सामान्य ज्ञान र सामान्य बौद्धिक परीक्षण

#### १. सामान्य ज्ञान:

- क) नेपालको भुगोल र आर्थिक तथा सामाजिक क्रियाकलाप: धरातलीय स्वरूपको किसिम र विशेषता, नेपालमा पाइने हावापानीको किसिम र विशेषता, तालतलैया, खनिज पदार्थ, प्राकृतिक स्रोत साधन, यातायात, विद्युत, शिक्षा, स्वास्थ्य, संचार, कृषि, उद्योग, पर्यटन, र व्यापार सम्बन्धी जानकारी ।
- ख) नेपालको सामाजिक एवं सांस्कृतिक अवस्था: प्रथा, परम्परा, धर्म, जाजाति, भाषाभाषी, संस्कृति र साहित्य ।
- ग) राष्ट्रिय महत्वका समसामायिक घटना तथा नविनतम गतिविधिहरू खेलकुद, पुरस्कार, कला, साहित्य लगायत महत्वपूर्ण व्यक्तित्वहरू सम्बन्धी जानकारी
- घ) नेपालको संघीय, प्रादेशीक र स्थानीय संरचना तथा शासन प्रणाली सम्बन्धी जानकारी ।
- ङ) विश्वको भुगोल: महादेश, महासागर, अक्षांश, देशान्तर, अन्तराष्ट्रिय तिथि रेखा, समय, पर्वतश्रृंखला, नदी, हिमनदी, ताल र हिमताल ।

#### २. बौद्धिक परीक्षण:

##### २.१ Verbal and non-verbal aptitude-शाब्दिक/अशाब्दिक तार्किक

Vocabulary, Alphabetical ordering of words, classification, Coding-Decoding, Insert the missing character, Direction and Distance sense test, Ranking order test, Relationship Test, Logical sequence of words Common Sense test, Assertion and Reason, Logical reasoning Figure series, Figure analogy, Figure Classification, Figure Matrix, Pattern completion/finding construction of squares and triangle, Analytical reasoning.

##### २.२ Numerical ability and Quantitative Aptitude-मात्रात्मक (संख्यात्मक/अंक सम्बन्धी) तार्किक

परीक्षण: Arithmetical reasoning, Insert the correct mathematical signs, Decimal and fraction, Percentage, Ratio, average, Profit and Loss, time and work.

### खण्ड (ख) सेवा सम्बन्धी सामान्य विषय (Service Related General Issues)

#### (१) संविधान र ऐन, नियमहरू

- १.१ नेपालको संविधान
- १.२ आर्थिक प्रशासन विनियमावली, २०६४
- १.३ कर्मचारी प्रशासन विनियमावली, २०६४ (संशोधन सहित)
- १.४ कम्पनी ऐन, २०६३

- १.५ खानेपानी व्यवस्थापन बोर्ड ऐन, २०६३
- १.६ खानेपानी महशुल निर्धारण आयोग ऐन, २०६३
- १.७ सार्वजनिक खरिद ऐन, २०६३
- १.८ सार्वजनिक खरिद नियमावली, २०६४
- १.९ भ्रष्टाचार निवारण ऐन, २०५९
- १.१० खानेपानी तथा सरसफाई नीति २०७१
- १.११ सुचनाको हक सम्बन्धी ऐन, २०६४
- १.१२ खानेपानी सेवा संचालन सम्बन्धी निर्देशिका, २०६९
- १.१३ Ethics and professionalism: code of conduct and guidelines for professional engineering practices
- १.१४ Nepal Engineering Council Act, 2055 and regulations, 2057

## (२) काठमाण्डौ उपत्यका खानेपानी लिमिटेड सम्बन्धी

- २.१ काठमाण्डौ उपत्यका खानेपानी लिमिटेडको ऐतिहासिक पृष्ठभूमि तथा विद्यमान सांगठनिक संरचना ।
- २.२ सार्वजनिक नीजि साझेदारी (Public Private Partnership) को अवधारणा तथा सार्वजनिक नीजि साझेदारी (Public Private Partnership) मा खानेपानी व्यवस्थापन भएका केही मुलुकहरूको संक्षिप्त जानकारी ।
- २.३ खानेपानी महशुल निर्धारण आयोग तथा काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन बोर्ड ।
- २.४ आयोजना कार्यान्वयन निर्देशनालय ।
- २.५ काठमाण्डौ उपत्यका खानेपानी लिमिटेडको प्रबन्धपत्र ।
- २.३ काठमाण्डौ उपत्यका खानेपानी लिमिटेडको नियमावली ।
- २.७ काठमाण्डौ उपत्यका खानेपानी लिमिटेडका शेयरधनीहरू बिचको सम्झौता तथा काठमाण्डौ उपत्यका खानेपानी लिमिटेड र काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन बोर्ड बीचको Lease Agreement र अनुमति पत्र ।
- २.८ काठमाण्डौ उपत्यका भित्रको खानेपानी व्यवस्थापन र चुनौती ।

## ३. Construction Management

- ३.१ Project Definition and Characteristics, Project Lifecycle
- ३.२ Project Planning and Scheduling
- ३.३ Planning Tools: CPM PERT and Bar charts
- ३.४ Project Monitoring and Control
- ३.५ Project Financing

## ४. Engineering Economics

- ४.१ Types of engineering economics decisions
- ४.२ Time Value of Money: Simple interest, Compound interest, Continuous compound interest

४.३ Project Evaluation Techniques: Payback period method, NPV method, Future value analysis, IRR method

४.४ Benefit and Cost Analysis: Cost benefit ratio, breakeven analysis

४.५ Corporate tax system in Nepal

४.६ Depreciation and its type

#### **५. Professional Practice**

५.२ Ethics and Professionalism: Perspective on morals, Codes of ethics and guidelines of professional engineering practice

५.२ Legal aspects of Professional Engineering in Nepal: Engineering Council act, Provision for private practice and employee engineers

५.३ Contract law

५.४ Tendering and contract documents

प्राविधिक सेवा, इलेक्ट्रो मेकानिकल समुह तह-७ ईन्जिनियर पदको

द्वितीय पत्र: सेवा सम्बन्धी सामान्य बिषय

(१०० अंक)

### **1. Work shop technology and Metrology**

1.1 Basic tools and Basic hand operations

1.2 Machine tools: Lathe, Shaper, Milling, Grinding, Drilling Machines

1.3 Metal Joining: Soldering, Brazing, Gas welding, Arc welding

1.4 Types of fits

1.5 Linear Measurement: Block Gages, Length Bars, Comparators

1.3 Errors in measurement

### **2. Thermodynamics and Heat Engine**

2.1 Basic Concepts: Thermodynamic System, Thermodynamic Property, Pure Substance, Zeroth Law

2.2 First Law of Thermodynamics: Control mass and Control volume formulation

2.3 Second Law of Thermodynamics: Heat engine, Refrigerator and Heat pump, Kelvin Planck and Clausius Statements, Entropy

2.4 Refrigeration: Reversed Carnot cycle, Vapor compression cycle, Absorption refrigeration systems, Refrigerants and their properties

2.5 Air Conditioning: Psychometric properties and psychometric chart, Heating, cooling, humidification and dehumidification process, Air conditioning systems

2.3 Thermodynamic Cycles: Carnot cycle, Otto cycle, Diesel Cycle, Brayton cycle, Rankine cycle

2.7 IC engines: Classifications, components, two stroke and four stroke operations, performance of IC engines, Ignition system, Cooling system, Lubrication system

2.8 Modes of heat transfer: Conduction, Convection and Radiation

### **3. Fluid Mechanics**

3.1 Fluid Properties: Viscosity, Surface tension, Compressibility, Vapor Pressure

3.2 Fluid Statics: Pressure variations in static fluid, Pressure head, Manometer, Force on submerged surfaces

3.3 Concept of Water Hammer, Formula of Joukowsky. Protection against Water Hammer.

3.4 Equations of Fluid Flow: Types of flow, Continuity equation, Bernoulli's equation, and Momentum equation

3.5 Viscous Effects: Reynolds number, Boundary layer, Frictional resistance to flow in pipes, Darcy-Weisbach Equation and Hazen-Williams Equation for determining frictional head loss in a pipeline,

3.3 Flow measurement: Pitot-static tube, Orifice, Venturimeter, Nozzle, Rotameter

#### **4. Hydrodynamic and Electric Machines**

4.1 Water turbines: Pelton, Francis, Kaplan and Cross flow (Working principle and Characteristic)

4.2 Pumps: Pumps with free water surface, Positive Displacement, Roto dynamic and Injection Pumps (Working principle and Characteristic), Hydraulic ram

4.3 DC Motors: Shunt field, Series field and Compound field motors, Torque- speed Characteristics

4.4 DC Generators: Shunt, Series and Compound field machines, Voltage/speed/load characteristics, Effects of variable load, variable torque

4.5 Synchronous and Induction Machines: Basic structure of synchronous machines, Generator on isolated load, Generator on large system, Synchronous motor

4.3 Transformer : Constructional detail, Operating principle, Equivalent Circuit, Losses and efficiency, Voltage regulation, Exciting current harmonics, Transformer inrush current, Transformer tests, Auto transformer, Three phase transformer connections, Parallel operation.

#### **5. D.C. Circuit Analysis**

5.1 Circuit elements: Resistor, Inductor and Capacitor

5.2 Dependent and independent current source and voltage source

5.3 Ohms law, Kirchoff's law, nodal and mesh analysis

5.4 Series and parallel circuit, delta-star and star-delta transformation

5.5 Network Theorem: Thevenins theorem, Nortons theorem, Superposition theorem, Reciprocity theorem and Maximum power transfer theorem.

5.3 Transient response of RLC circuit excited by DC source

#### **6. A.C. Circuit Analysis**

- 6.1 Alternating voltage and current, average and RMS value.
- 6.2 RLC series and parallel circuits, Phasor algebra
- 6.3 Concept of complex Impedance and Admittance
- 6.4 Resonance in series and parallel RLC circuit, bandwidth and effect of Q-factor
- 6.5 Active, Reactive and Apparent power
- 6.6 Transient response of RLC circuit excited by AC source
- 6.7 Fourier series and Fourier Transform
- 6.8 Two-port network: Z, Y, T and h parameters, T to  $\Gamma$  and  $\Gamma$  to T transformation, two-port network connection
- 6.9 Generation of three-phase voltages, star and delta connections, current and voltage relation in star and delta connections, three phase power measurement.
- 6.10 concept of Power Factor and methods of its improvement.

## **7. Instrumentation**

- 7.1 Transducers: Measurement of electrical, mechanical, thermal and hydraulic variables
- 7.2 Moving Coil and Moving Iron Instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter and Power Factor Meter
- 7.3 Accuracy and Precision: Parallax, Absolute and Relative Errors
- 7.4 Measurement of low, medium, high resistances and Megger
- 7.5 DC and AC bridge circuits
- 7.6 Operational Amplifier and filters: Ideal Op-Am, Feedback Op-Am, Adder, Signal Amplification, attenuation, differentiation and integration
- 7.7 Oscilloscope: Operating principles, Analog and Digital Oscilloscope
- 7.8 Analog to Digital and Digital to Analog converters: Weighted resistor type and Ladder type D/A converters, Dual-ramp type and Successive approximation type A/D converters
- 7.9 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation
- 7.10 Instrument Transformers: Construction and Operating Principles of Measuring

and Protection type CTs, Potential transformers

## **8. Generation, Transmission and Distribution**

8.1 Hydroelectric Power Plants: Hydraulic to electrical energy conversion, output power equation, classification, elements of hydroelectric power plant and schematic layouts, site selection, classification of water turbines, working principle of different types of water turbines, physical characteristics and efficiencies, governing of water turbines, selection of water turbines, essential features of hydroelectric alternators, auxiliaries in hydroelectric plant, advantages and disadvantages of hydroelectric plants.

8.2 Steam power Plants: Elements of a steam power plant and their schematic arrangement; working principle, vibration monitoring, governing, cooling efficiency, alternators used for steam turbine driven units

8.3 Diesel Power Plants: Elements of a diesel power plant, schematic arrangement; working principle, efficiency, cooling, governing, speed control, application, performance and thermal efficiency, alternators used for diesel units, advantages and disadvantages of diesel plants.

Sizing of a standby diesel power generator unit for a water pumping station, AMF and ATS system.

8.4 Non-Conventional method of power generation: Concept of solar photovoltaic, wind and geothermal method of power generation and their importance . Concept of a Wind-Solar PV hybrid power system with battery backup for a water pumping station.

8.5 Power transmission system: Overhead and underground transmissions, advantages and limitations of high voltage transmission; choice of working voltage, Conductor size and configuration, supports and cross arms, insulators used in overhead lines, vibration dampers sag tension calculation.

8.6 Power Distribution System: Voltage levels, primary and secondary distribution, radial and ring mains distribution, single phase and three phase ac distribution, pole/tower types, conductors and insulators used in distribution lines, distribution transformer and its accessories, protection coordination in distribution system.



8.7 Sizing of distribution transformer for a water pumping station.

## **9. Switchgear and Protection**

9.1 Fuse: Types, characteristics and operating principles

9.2 Magnetic Contactors: Types, construction, operating principles

9.3 Isolators (Disconnecting switches): types, construction and operating principles

9.4 MCB and MCCB: Construction, operating principles, characteristics

9.5 Relays: Electromagnetic and Static Relays, Over current Relay, Impedance Relay, Directional Relay

9.6 Circuit Breakers: ACB, OCB, ABCB, VCB and SF3 CB; construction, operating principles and applications

9.7 Protection schemes: Over current, under voltage, differential, distance protection

## **10. Work shop technology and Metrology**

10.1 Basic tools and Basic hand operations

10.2 Machine tools: Lathe, Shaper, Milling, Grinding, Drilling Machines

10.3 Metal Joining: Soldering, Brazing, Gas welding, Arc welding

10.4 Types of fits

10.5 Linear Measurement: Block Gages, Length Bars, Comparators

10.6 Errors in measurement

## **11. Machine Component Design and Drawing**

11.1 Types of Projection

11.2 Production Drawings

11.3 Terminologies of Mechanisms, Mobility and Degrees of Freedom

11.4 Design Process

11.5 Factors Affecting Choice of Materials for Design: Strength, Toughness, Durability, Hardness

11.6 Loading: Tensile, Compressive, Shearing, Bending, Bearing and Torsion

11.7 Common Types of Failure: Theories of failure, Stress concentration effects, Ductile and brittle materials, Factor of safety

## **12. Thermodynamics and Heat Engines**

- 12.1 Basic Concepts: Thermodynamic System, Thermodynamic Property, Pure Substance, Zeroth Law
- 12.2 First Law of Thermodynamics: Control mass and Control volume formulation
- 12.3 Second Law of Thermodynamics: Heat engine, Refrigerator and Heat pump, Kelvin Planck and Clausius Statements, Entropy
- 12.4 Refrigeration: Reversed Carnot cycle, Vapor compression cycle, Absorption refrigeration systems, Refrigerants and their properties
- 12.5 Air Conditioning: Psychometric properties and psychometric chart, Heating, cooling, humidification and dehumidification process, Air conditioning systems
- 12.6 Thermodynamic Cycles: Carnot cycle, Otto cycle, Diesel Cycle, Brayton cycle, Rankine cycle
- 12.7 IC engines: Classifications, components, two stroke and four stroke operations, performance of IC engines, Ignition system, Cooling system, Lubrication system
- 12.8 Modes of heat transfer: Conduction, Convection and Radiation

## **Section B -**

### **1. Network Analysis**

- 1.1 Ohms law, Kirchoff's law, nodal and mesh analysis
- 1.2 Series and parallel circuit, delta-star and star-delta transformation
- 1.3 Concept of complex Impedance and Admittance RLC series and parallel circuit  
Network Theorem: Thevenins theorem, Nortons theorem, Superposition theorem, Reciprocity theorem and Maximum power transfer theorem.
- 1.4 Resonance in series and parallel RLC circuit
- 1.5 Active, Reactive and Apparent power
- 1.6 Transient response of RLC circuit excited by DC and AC sources
- 1.7 Fourier analysis
- 1.8 Two-port network: Z, Y, T and h parameters, T to  $\Delta$  and  $\Delta$  to T transformation, two-port network connection
- 1.9 Three-phase circuit analysis, phase and line quantities

### **2. Electrical Supply Systems**

- 2.1 Power Plants: components of hydro power plant, Steam power Plants and Diesel

Power Plants; Turbine classifications, governing systems, Plant use factor; load sharing between base load and peak load plants

2.2 Transmission system: Overhead and underground transmissions, EHV AC and HVDC Transmission.

2.3 Electrical and Mechanical design of Over head AC transmission: Selections of conductor size and configuration, supports and cross arms, insulators, sag and tension calculation.

2.4 Power Distribution System: primary and secondary distribution, Distribution network layouts, protection coordination in distribution system.

### **3. Measurement and Instrumentation**

3.1 Accuracy, Precision, Absolute and Relative Errors, Parallax

3.2 Deflection type measuring instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter

3.3 Instrument Transformers: Operating Principles of Measuring and Protection type CTs, Potential transformers

3.4 Transducers: Tachometer, potentiometer, Measurement of electrical, Mechanical, thermal and hydraulic variables

3.5 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation

### **4 Power System Protection**

4.1 Fuse, Magnetic Contactors, Isolators, MCB and MCCB: characteristics and operating principles

4.2 Relays: Electromagnetic and Static Relays, Over current Relay, Impedance Relay, Directional Relay

4.3 Circuit Breakers: ACB, OCB, ABCB, VCB and SF3 CB; construction, operating principles and applications

4.4 Protection schemes: Over current, Over and under voltage, differential, distance protection

4.5 Grounding: System and equipment grounding, electric shock, safe value of current and voltages, touch and step potentials, Ground Fault Current Interrupters

### **Section C**

## **1. Machines**

1.1 Water turbines: Pelton, Francis, Kaplan and Cross flow (Working principle and Characteristic)

1.2 Pumps: Positive Displacement Pump, Rotodynamic Pump, Injection Pump and Pump with free water surface (Working principle and Characteristic), Hydraulic ram

1.3 DC Motors: Shunt field, Series field and Compound field motors, Torque–speed characteristics

1.4 DC Generators: Shunt, Series and Compound field machines, Voltage/speed/load Characteristics, Effects of variable load, variable torque

1.5 Synchronous and Induction Machines: Basic structure of synchronous machines, Generator on isolated load, Generator on large system, Synchronous motor

## **2 Control System**

2.1 Mathematical modeling: differential equation representation, transfer function notations and state space representations of physical systems, Block diagram algebra, signal flow graphs.

2.2 Transient and steady state response: impulse response, step and ramp response analysis of a 1st and 2nd order systems, overshoot and damping, steady state error and error constants

2.3 Effect of feedback on stability and steady state error

2.4 Stability: Relative and absolute stability, Routh -Herwitz criterion.

2.5 Root locus: Manual plotting and judging the relative stability using root locus technique.

2.6 Frequency response: Polar, and Bode plots, stability in frequency domain, gain margin and phase margins, Nyquist criterion for stability.

2.7 Root locus: Manual plotting and judging the relative stability using root locus technique.

2.8 Control system design: lead-lag and PID controllers and setting the controller parameters using Root locus and Bode plots.

## **3. Maintenance Management**

3.1 Maintenance objectives and maintenance costs

3.2 Types of maintenance schemes

3.3 Basic maintenance decisions

#### **4. Automobile Engineering**

4.1 Classification of vehicles

4.2 Components of an automobile: Power transmission system, Suspension system,  
Brakes

4.3 Emission control system: Major pollutant and methods of reduction