

# काठमाडौं उपत्यका खानेपानी लिमिटेड

प्राबिधिक सेवा, इलेक्ट्रोमेकानिकल समूह, ७ तह, इन्जिनियर पदको खुल्ला तथा समावेशी र आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

पाठ्यक्रमको रूपरेखा :- यस पाठ्यक्रमको आधारमा निम्नानुसार दुई चरणमा परीक्षा लिइने छ :

प्रथम चरण :- लिखित परीक्षा

पूर्णाङ्क :- २००

द्वितीय चरण :- अन्तर्वार्ता

पूर्णाङ्क :- ३०

## १क० प्रथम चरण – लिखित परीक्षा योजना (Examination Scheme)

पत्र	विषय	पूर्णाङ्क	उत्तीर्णाङ्क	परीक्षा प्रणाली	प्रश्न संख्या X अङ्कभार	समय
प्रथम	मेकानिकल तथा इलेक्ट्रिकल सम्बन्धि	१००	४०	वस्तुगत बहुवैकल्पिक (MCQs)	१०० X १ = १००	१ घण्टा १५ मिनेट
द्वितीय	मेकानिकल तथा इलेक्ट्रिकल सम्बन्धि	१००	४०	विषयगत (Subjective)	१० X ५ = ५० र ५ X १० = ५०	३ घण्टा

## १ख० द्वितीय चरण

विषय	पूर्णाङ्क	परीक्षा प्रणाली	समय
व्यक्तिगत अन्तर्वार्ता	३०	मौखिक	-

- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुवै हुन सक्नेछ ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- वस्तुगत बहुवैकल्पिक (Multiple Choice) प्रश्नहरूको गलत उत्तर दिएमा प्रत्येक गलत उत्तर बापत २० प्रतिशत अङ्क कट्टा गरिनेछ । तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन ।
- प्रथम पत्रका पाठ्यक्रमका एकाईहरूबाट सोधिने प्रश्नहरूको संख्या निम्नानुसार हुनेछ । द्वितीय पत्रको पाठ्यक्रमका एकाईहरूबाट सोधिने प्रश्नहरूको संख्या द्वितीयपत्रको पाठ्यक्रम उल्लेख भए अनुसार हुनेछ ।

प्रथमपत्रका एकाई	1	2	3	4	5	6	7	8	9	10	11	12
प्रश्न संख्या	5	10	5	10	10	10	10	10	10	8	8	4
- बहुवैकल्पिक प्रश्नहरू हुने परीक्षामा कुनै प्रकारको क्याल्कुलेटर (Calculator) प्रयोग गर्न पाइने छैन ।
- विषयगत प्रश्नका लागि द्वितीय पत्रको विषयगत प्रश्नका लागि १० अङ्कका ५ ओटा लामो प्रश्न र ५ अङ्कका १० ओटा छोटो प्रश्न सोधिने छन ।
- द्वितीय पत्रमा प्रत्येक खण्डका लागि छुट्टाछुट्टै उत्तरपुस्तिकाहरू हुनेछन् । परीक्षार्थीले प्रत्येक खण्डका प्रश्नहरूको उत्तर सोही खण्डको उत्तरपुस्तिकामा लेख्नुपर्नेछ ।
- यस पाठ्यक्रम योजना अन्तर्गतका पत्र/विषयका विषयवस्तुमा जेसुकै लेखिएको भए तापनि पाठ्यक्रममा परेका कानून, ऐन, नियम तथा नीतिहरू परीक्षाको मिति भन्दा ३ महिना अगाडि (संशोधन भएका वा संशोधन भई हटाईएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा परेको सम्झन पर्दछ ।
- यस भन्दा अगाडि लागू भएको माथि उल्लिखित समूहको पाठ्यक्रम खारेज गरिएको छ ।
- पाठ्यक्रम लागू मिति :- २०७४ आश्विन देखि

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## प्रथम पत्र :- मेकानिकल तथा इलेक्ट्रीकल इन्जिनियरिङ्ग सम्बन्धि

- 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
  - 1.6 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
  - 2.6 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 Joukowski. 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,
  - 3.6 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)

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- 4.2 Pumps: Pumps with free water surface, Positive Displacement, Rotodynamic 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
  - 4.6 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.
  - 5.6 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, Phaser 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  $\square$  and  $\square$  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.

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आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

## 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,

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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 SF<sub>6</sub> CB; construction, operating principles and applications
- 9.7 Protection schemes: Over current, under voltage, differential, distance protection

## 10. Construction Management

- 10.1 Project Definition and Characteristics, Project Lifecycle
- 10.2 Project Planning and Scheduling
- 10.3 Planning Tools: CPM PERT and Barcharts
- 10.4 Project Monitoring and Control
- 10.5 Project Fincancing

## 11. Engineering Economics

- 11.1 Types of engineering economics decisions
- 11.2 Time Value of Money: Simple interest, Compound interest, Continuous compound interest
- 11.3 Project Evaluation Techniques: Payback period method, NPV method, Future value analysis, IRR method
- 11.4 Benefit and Cost Analysis: Cost benefit ratio, breakeven analysis
- 11.5 Corporate tax system in Nepal
- 11.6 Depreciation and its type

## 12. Professional Practice

- 12.1 Ethics and Professionalism: Perspective on morals, Codes of ethics and guidelines of professional engineering practice
- 12.2 Legal aspects of Professional Engineering in Nepal: Engineering Council act, Provision for private practice and employee engineers
- 12.3 Contract law
- 12.4 Tendering and contract documents

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आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम  
द्वितीय पत्र :- मेकानिकल, इलेक्ट्रिकल र KUKL सम्बन्धि

## Section A [1X10=10 and 2x5=10]

### 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
- 1.6 Errors in measurement

### 2. Machine Component Design and Drawing

- 2.1 Types of Projection
- 2.2 Production Drawings
- 2.3 Terminologies of Mechanisms, Mobility and Degrees of Freedom
- 2.4 Design Process
- 2.5 Factors Affecting Choice of Materials for Design: Strength, Toughness, Durability, Hardness
- 2.6 Loading: Tensile, Compressive, Shearing, Bending, Bearing and Torsion
- 2.7 Common Types of Failure: Theories of failure, Stress concentration effects, Ductile and brittle materials, Factor of safety

### 3. Thermodynamics and Heat Engines

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

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## Section B - [3X10=30 and 2x5=10]

### 4. Network Analysis

- 4.1 Ohms law, Kirchoff's law, nodal and mesh analysis
- 4.2 Series and parallel circuit, delta-star and star-delta transformation
- 4.3 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.
- 4.4 Resonance in series and parallel RLC circuit
- 4.5 Active, Reactive and Apparent power
- 4.6 Transient response of RLC circuit excited by DC and AC sources
- 4.7 Fourier analysis
- 4.8 Two-port network: Z, Y, T and h parameters, T to  $\Pi$  and  $\Pi$  to T transformation, two-port network connection
- 4.9 Three-phase circuit analysis, phase and line quantities

### 5 Electrical Supply Systems

- 5.1 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
- 5.2 Transmission system: Overhead and underground transmissions, EHV AC and HVDC Transmission.
- 5.3 Electrical and Mechanical design of Over head AC transmission: Selections of conductor size and configuration, supports and cross arms, insulators, sag and tension calculation.
- 5.4 Power Distribution System: primary and secondary distribution, Distribution network layouts, protection coordination in distribution system.

### 6. Measurement and Instrumentation

- 6.1 Accuracy, Precision, Absolute and Relative Errors, Parallax
- 6.2 Deflection type measuring instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter
- 6.3 Instrument Transformers: Operating Principles of Measuring and Protection type CTs, Potential transformers
- 6.4 Transducers: Tachometer, potentiometer, Measurement of electrical, mechanical, thermal and hydraulic variables
- 6.5 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation

### 7 Power System Protection

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

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

7.3 Circuit Breakers: ACB, OCB, ABCB, VCB and SF<sub>6</sub> CB; construction, operating principles and applications

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

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

## Section C - [1X10=10 and 4x5=20]

### 8. Machines

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

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

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

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

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

### 9 Control System

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

9.2 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

9.3 Effect of feedback on stability and steady state error

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

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

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

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

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



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## 10. Maintenance Management

- 9.1 Maintenance objectives and maintenance costs
- 9.2 Types of maintenance schemes
- 9.3 Basic maintenance decisions

## 11. Automobile Engineering

- 11.1 Classification of vehicles
- 11.2 Components of an automobile: Power transmission system, Suspension system, Brakes
- 11.3 Emission control system: Major pollutant and methods of reduction

## Section D - [2x5=10]

## 12. काठमाण्डौ उपत्यका खानेपानी लिमिटेड सम्बन्धी

- 12.1 खानेपानी महशुल निर्धारण आयोग
- 12.2 काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन बोर्ड
- 12.3 आयोजना कार्यान्वयन निर्देशनालय
- 12.4 काठमाण्डौ उपत्यका खानेपानी लिमिटेडको ऐतिहासिक पृष्ठभूमि र सांगठनिक संरचना
- 12.5 काठमाण्डौ उपत्यका खानेपानी लिमिटेडका प्रबन्धपत्र
- 12.6 काठमाण्डौ उपत्यका खानेपानी लिमिटेडका नियमावली
- 12.7 काठमाण्डौ उपत्यका खानेपानी लिमिटेडका सेयरधनीहरू बिचको सम्झौता
- 12.8 काठमाण्डौ उपत्यका खानेपानी लिमिटेड र काठमाण्डौ उपत्यका खानेपानी व्यवस्थापन बोर्ड बीचको Lease Agreement र अनुमति पत्र
- 12.9 कर्मचारी प्रशासन विनियमावली, २०६४
- 12.10 आर्थिक प्रशासन विनियमावली, २०६४
- 12.11 राष्ट्रिय खानेपानीको गुणस्तर मापदण्ड, २०६२