

लोक सेवा आयोग
संघीय संसद सेवा, प्राविधिक समूह, राजपत्राङ्कित तृतीय श्रेणी, इलेक्ट्रिकल इन्जिनियर पदको खुला
प्रतियोगितात्मक परीक्षाको पाठ्यक्रम
द्वितीय पत्र (Paper II): Technical Subject

Section A (30 Marks)

1. Electric Circuits

- 1.1 Circuit elements: Resistor, Inductor and Capacitor
- 1.2 Dependent and independent current source and voltage source
- 1.3 Ohm's law, Kirchoff's law, nodal and mesh analysis
- 1.4 Series and parallel circuit, delta-star and star-delta transformation
- 1.5 Network Theorem: Thevenin's theorem, Norton's theorem, Superposition theorem and Maximum power transfer theorem
- 1.6 Alternating voltage and current, average and RMS value
- 1.7 RLC series and parallel circuits, Phasor algebra
- 1.8 Resonance in series and parallel RLC circuit, bandwidth and Q-factor
- 1.9 Active, Reactive and Apparent power, Power Factor
- 1.10 Transient response of RLC circuit
- 1.11 Generation of three-phase voltages, star and delta connections, balanced and unbalanced load system, three phase power measurement

2. Electrical Machines

- 2.1 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
- 2.2 D.C. Machine: Constructional detail, Operating principle of dc generator, Voltage build-up process, Types of dc generator, their characteristics and applications, Losses and efficiency, Armature reaction and commutation, Operating principle of dc motor, Back emf, Types of dc motor, their characteristics and applications, DC motor starter, Speed control of dc motor
- 2.3 Induction machine: Constructional detail, Operating principle of three phase induction motor, Equivalent circuit, Torque-speed characteristic, Losses and efficiency, Starting methods, Speed control of three phase induction motor, Induction motor tests, Single phase induction motors- types, characteristics and applications, Induction Generator
- 2.4 Synchronous machine: Constructional detail, Operating principle of synchronous generator, Equivalent circuit, phasor diagram and power angle characteristics of cylindrical rotor machine and salient pole machine, Parallel operation of synchronous generators, Operating principle of synchronous motor, Starting methods, Effect of excitation on performance of synchronous motor, V and Inverted V curves

3. Basic Electronics

- 3.1 Bi-polar junction transistor: construction, operating characteristics, use as amplifier and switch
- 3.2 Logic circuit: Decimal, Binary and Hexadecimal system, logic gates, adder, Encoder, Decoder, Multiplexer and Demultiplexer
- 3.3 Power Electronics Devices: Thyristor, Triac, MOSFET, UJT, GTO – Construction and their characteristics
- 3.4 Rectifier: Rectifier using diodes - half wave, full wave, single phase, three phase, capacitor and inductor filters, Controlled rectifier using thyristors - half wave, full wave, single phase, three phase

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- 3.5 DC chopper: Step down chopper, Step up chopper, bi-directional dc-dc converter
- 3.6 Inverter: Single phase voltage inverter, three phase voltage inverter current source inverter
- 3.7 Cyclo-converter – Single phase and three phase
- 3.8 AC voltage controller – with resistive load and inductive load

Section B (20 Marks)

4. Instrumentation

- 4.1 Transducers: Measurement of electrical, mechanical, thermal and hydraulic variables
- 4.2 Moving Coil and Moving Iron Instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter and Power Factor Meter, Clamp-meter
- 4.3 Accuracy and Precision: Parallax, Absolute and Relative Errors, Calibration
- 4.4 Measurement of low, medium, high resistances and Megger
- 4.5 DC and AC bridge circuits
- 4.6 Operational Amplifier and filters: Ideal Op-Amp, Feedback Op-Amp, Adder, Signal Amplification, attenuation, differentiation and integration
- 4.7 Oscilloscope: Operating principles, Analog and Digital Oscilloscope
- 4.8 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
- 4.9 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation
- 4.10 Instrument Transformers: Construction and Operating Principles of Measuring and Protection type CTs, Potential transformers

5. Automatic Control System

- 5.1 Mathematical modeling: differential equation representation, transfer function and state space representations of a physical systems
- 5.2 Block diagram: block diagram representation of the control system components, signal flow graphs and Mason's Gain Formula
- 5.3 Time response: impulse response, step and ramp response analysis of a 1st and 2nd order systems, time response specifications
- 5.4 Steady state error: evaluation of the steady state error and error constants
- 5.5 Stability: Relative and absolute stability, Routh-Herwitz criterion
- 5.6 Controllers: lead-lag Compensators, PID controllers, derivative feedback controller
- 5.7 Root locus: judging the relative stability and setting controller parameters of a close loop control system using root locus technique
- 5.8 Frequency response: Stability Analysis and controller parameter selection from Frequency Response Methods

Section C (30 Marks)

6. Generation, Transmission And Distribution

- 6.1 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, water

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turbines governors, selection of water turbines, essential features of hydroelectric alternators, auxiliaries in hydroelectric plant, advantages and disadvantages of hydroelectric plants

- 6.2 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
- 6.3 Diesel Power Plants: Elements of a diesel power plant, schematic arrangement; working principle, efficiency, advantages and disadvantages of diesel plants, diesel generator as a back up power supply
- 6.4 Non-Conventional method of power generation: Solar photovoltaic system, Charge Controller, batteries, concentrated solar and wind power generation and their importance
- 6.5 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
- 6.6 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

7. Power System Analysis

- 7.1 Transmission line parameters: Computation of series and shunt parameters of transmission line equivalent circuits, concept of GMD and GMR, proximity effect and skin effect
- 7.2 Per unit system representation: Single line impedance and reactance diagrams
- 7.3 Transmission line performance: Lumped and distributed parameter modeling, ABCD parameters, efficiency & regulations calculations, Ferranti effect, surge impedance loading
- 7.4 Load flow: Types of buses, power system network, Gauss-Seidal and Newton-Rapshon methods
- 7.5 Transient and temporary Over voltages
- 7.6 VAR compensation: Real and reactive power flow through transmission line, series and shunt compensations, FACTS Devices
- 7.7 Fault calculations: Symmetrical components, grounded & ungrounded systems, L-G, L-L, L-L-G and 3-phase faults
- 7.8 Stability studies: Steady state & transient stability limits, swing equations, equal area criterion, stability enhancement techniques
- 7.9 Corona: corona inception voltage, power loss, waveform deformation, RI and AN due to corona

8. Switchgear And Protection

- 8.1 Fuse: Types, characteristics and operating principles
- 8.2 Magnetic Contactors: Types, construction, operating principles
- 8.3 Isolators (Disconnecting switches): types, construction and operating principles
- 8.4 MCB and MCCB: Construction, operating principles, characteristics
- 8.5 Relays: Electromagnetic and Static Relays, Over current Relay, Impedance Relay, Directional Relay
- 8.6 Circuit Breakers: ACB, OCB, ABCB, VCB and SF6 CB; construction, operating principles and applications

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- 8.7 Lighting Arrestors: Purpose, types and characteristics
- 8.8 Protection schemes: Over current, under voltage, differential, distance protection
- 8.9 Grounding: System and equipment grounding, electric shock, safe value of current and voltages, touch and step potentials, Ground Fault Current Interrupters
- 8.10 BIL, Insulation co-ordination of power system equipments

Section D (20 Marks)

9. Utilization Of Electrical Energy

- 9.1 Economic considerations: Cost classification; interest and depreciation
- 9.2 Load characteristics: load curves, load duration curve, demand factor; load factor, diversity factor, causes of low power factor and its disadvantages, power factor improvement and its economics
- 9.3 Plant use factor; load sharing between base load and peak load plants
- 9.4 Tariff: objective, factors affecting tariff, types of tariff
- 9.5 Illumination: Illumination and luminance, radiant efficiency, plane and solid angles, laws of illumination; polar curves, illumination requirement, design of indoor and out-door lighting scheme
- 9.6 Lamps: Incandescent lamps, arc lamps, sodium discharge lamps, mercury fluorescent lamps, high pressure mercury vapor lamps
- 9.7 Wiring Systems: General rules and methods of wiring, Types of wiring, types of cable and selection, Main Switch and distribution boards, lighting accessories and fittings
- 9.8 Equipments grounding, earthing and its types

10. Power Sector of Nepal and requirement of its reform

- 10.1 History of power development in Nepal; hydro power potential; energy supply demand trends; challenges and prospects of hydropower development; role of government institutions; NEA and private sectors in power development; concept of deregulation and unbundling; Concept of independent regulatory commission; efforts towards power sector reform
- 10.2 Salient features of hydro power plants; current scenario of transmission and distribution networks and substations in Nepal
- 10.3 Cross border power exchange opportunities and development
- 10.4 Power sector scenario in current periodic plan
- 10.5 Solar power status, opportunities and challenges in Nepal
- 10.6 Role of power sector to the overall development of the nation

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नेपाल आर्थिक योजना तथा तथ्याङ्क, इन्जिनियरिङ्ग, कृषि, वन, संघीय संसद, विविध र शिक्षा सेवाका सबै
समूह/उपसमूह, राजपत्राङ्कित तृतीय श्रेणी एवं स्वास्थ्य सेवाको सातौं र आठौं तहका पदहरूमा प्रथम चरणको
लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र
लिइने **सामूहिक परीक्षण (Group Test)** को लागि

सामूहिक छलफल (Group Discussion)

यस प्रयोजनको लागि गरिने परीक्षण १० पूर्णाङ्क र ३० मिनेट अवधिको हुनेछ जुन नेता विहिन सामूहिक छलफल (Leaderless Group Discussion) को रूपमा अवलम्बन गरिने छ। दिइएको प्रश्न वा Topic का विषयमा पालैपालोसँग निर्दिष्ट समय भित्र समूह बीच छलफल गर्दै प्रत्येक उम्मेदवारले व्यक्तिगत प्रस्तुति (Individual Presentation) गर्नु पर्नेछ। यस परीक्षणमा मूल्याङ्कनको लागि देहाय अनुसारको ३ जना भन्दा बढीको समिति रहनेछ।

आयोगका सदस्य	-	अध्यक्ष
मनोविज्ञ	-	सदस्य
दक्ष/विज्ञ (१ जना)	-	सदस्य

सामूहिक छलफलमा दिइने नमुना प्रश्न वा Topic

उदाहरणको लागि - उर्जा संकट, गरीबी निवारण, स्वास्थ्य बीमा, खाद्य सुरक्षा, प्रतिभा पलायन जस्ता Topics मध्ये कुनै एक Topic मात्र दिइनेछ।