

लोक सेवा आयोग

नेपाल इन्जिनियरिङ्ग सेवा, इलेक्ट्रिकल इन्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल इन्जिनियरिङ्ग उपसमूह तथा नेपाल संसद सेवा, इन्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल उपसमूह, राजपत्राङ्कित तृतीय श्रेणीको 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

प्रथम चरण – लिखित परीक्षा योजना (Examination Scheme)

| पत्र    | विषय                         | पूर्णाङ्क | उत्तीर्णाङ्क | परीक्षा प्रणाली                    | प्रश्न संख्या X अङ्कभार | समय              |
|---------|------------------------------|-----------|--------------|------------------------------------|-------------------------|------------------|
| प्रथम   | इलेक्ट्रिकल इन्जिनियरिङ्ग I  | १००       | ४०           | वस्तुगत बहुउत्तर (Multiple Choice) | १००X१ = १००             | १ घण्टा १५ मिनेट |
| द्वितीय | इलेक्ट्रिकल इन्जिनियरिङ्ग II | १००       | ४०           | विषयगत (Subjective)                | १०X१० = १००             | ३ घण्टा          |

द्वितीय चरण

| विषय                   | पूर्णाङ्क | परीक्षा प्रणाली |
|------------------------|-----------|-----------------|
| व्यक्तिगत अन्तर्वार्ता | ३०        | मौखिक           |

- लिखित परीक्षाको माध्यम भाषा नेपाली वा अंग्रेजी अथवा नेपाली र अंग्रेजी दुवै हुन सक्नेछ ।
- पाठ्यक्रमको प्रथम र द्वितीय पत्रको विषयवस्तु फरक फरक हुनेछन ।
- माथि उल्लिखित उपसमूहको पाठ्यक्रमको प्रथमपत्रको विषयवस्तु एउटै हुनेछ । द्वितीयपत्रका विषयवस्तु उपसमूह अनुसार फरक फरक हुनेछन् ।
- प्रथम र द्वितीय पत्रको लिखित परीक्षा छुट्टाछुट्टै हुनेछ ।
- प्रथम तथा द्वितीय पत्रहरूका एकाइहरूबाट सोधिने प्रश्नसंख्या निम्नानुसार हुनेछ :

| प्रथम पत्रका एकाई   | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|---------------------|----|----|----|----|----|----|----|----|----|----|
| प्रश्न संख्या       | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| द्वितीय पत्रका खण्ड | A  |    | B  |    | C  |    |    | D  |    |    |
| द्वितीय पत्रका एकाई | 1  | 10 | 2  | 8  | 3  | 5  | 6  | 4  | 7  | 9  |
| प्रश्न संख्या       | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

- प्रथम पत्रमा वस्तुगत बहुउत्तर (Multiple Choice) प्रश्नहरूको उत्तर सही दिएमा प्रत्येक सही उत्तर बापत १ (एक) अङ्क प्रदान गरिनेछ भने गलत उत्तर दिएमा प्रत्येक गलत उत्तर बापत २० प्रतिशत अर्थात् ०.२ अङ्क कट्टा गरिनेछ । तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन ।
- द्वितीय पत्रको विषयगत प्रश्नका लागि तोकिएका १० अङ्कका प्रश्नहरूको हकमा १० अङ्कको एउटा लामो प्रश्न वा एउटै प्रश्नका दुई वा दुई भन्दा बढी भाग (Two or more parts of a single question) वा एउटा प्रश्न अन्तर्गत दुई वा बढी टिप्पणीहरू (Short notes) सोध्न सकिने छ ।
- द्वितीय पत्रको पाठ्यक्रमलाई ४ वटा खण्ड/एकाईमा विभाजन गरिएको छ, ४ वटा खण्ड/एकाईको लागि ४ वटै उत्तर पुस्तिका दिइनेछ र परिक्षार्थीले प्रत्येक खण्ड/एकाईका प्रश्नहरूको उत्तर सोही खण्ड/एकाईको उत्तर पुस्तिकामा लेख्नु पर्नेछ ।
- यस पाठ्यक्रममा जेसुकै लेखिएको भएता पनि पाठ्यक्रममा परेका ऐन, नियमहरू परीक्षाको मिति भन्दा ३ (तीन) महिना अगाडि (संशोधन भएका वा संशोधन भई हटाइएका वा थप गरी संशोधन भई) कायम रहेकालाई यस पाठ्यक्रममा रहेको सम्झनु पर्दछ ।
- प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई मात्र द्वितीय चरणको अन्तर्वार्तामा सम्मिलित गराइनेछ ।
- यस भन्दा अगाडि लागू भएको माथि उल्लिखित समूहको पाठ्यक्रम खारेज गरिएको छ ।
- पाठ्यक्रम लागू मिति :- २०६३/२/३० देखि

प्रथम पत्र :- इलेक्ट्रिकल इन्जिनियरिङ्ग I

**1 D.C. CIRCUIT ANALYSIS**

- 1.1 Circuit elements: Resistor, Inductor and Capacitor
- 1.2 Dependent and independent current source and voltage source
- 1.3 Ohms law, Kirchoff's law, nodal and mesh analysis
- 1.4 Series and parallel circuit, delta-star and star-delta transformation
- 1.5 Network Theorem: Thevenins theorem, Nortons theorem, Superposition theorem, Reciprocity theorem and Maximum power transfer theorem.
- 1.6 Transient response of RLC circuit excited by DC source

**2 A.C. CIRCUIT ANALYSIS**

- 2.1 Alternating voltage and current, average and RMS value.
- 2.2 RLC series and parallel circuits, Phasor algebra
- 2.3 Concept of complex Impedance and Admittance
- 2.4 Resonance in series and parallel RLC circuit, bandwidth and effect of Q-factor
- 2.5 Active, Reactive and Apparent power
- 2.6 Transient response of RLC circuit excited by AC source
- 2.7 Fourier series and Fourier Transform
- 2.8 Two-port network: Z, Y, T and h parameters, T to  $\Pi$  and  $\Pi$  to T transformation, two-port network connection
- 2.9 Generation of three-phase voltages, star and delta connections, current and voltage relation in star and delta connections, three phase power measurement

**3 ELECTRICAL MACHINES**

- 3.1 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.
- 3.2 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 motors starter, Speed control of dc motor
- 3.3 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, Induction generator, Single phase induction motors-types, characteristics and applications .
- 3.4 Synchronous machine: Constructional detail, Operating principle of synchronous generator, Armature reaction, 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.

#### **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
- 4.3 Accuracy and Precision: Parallax, Absolute and Relative Errors
- 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-Am, Feedback Op-Am, 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 GENERATION, TRANSMISSION AND DISTRIBUTION**

- 5.1 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.
- 5.2 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
- 5.3 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.
- 5.4 Non-Conventional method of power generation: Concept of solar photovoltaic, wind and geothermal method of power generation and their importance
- 5.5 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.
- 5.6 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.

## **6 POWER SYSTEM ANALYSIS**

- 6.1 Transmission line parameters: Computation of series and shunt parameters of transmission line equivalent circuits, concept of GMD and GMR, proximity effect and skin effect.
- 6.2 Per unit system representation: Single line impedance and reactance diagrams
- 6.3 Transmission line performance: Lumped and distributed parameter modeling, ABCD parameters, efficiency & regulations calculations, Ferranti effect, surge impedance loading
- 6.4 Load flow: Y-bus of a power system network, Gauss-Seidal and Newton-Raphson methods
- 6.5 Over voltages in transmission lines: Power frequency, switching and lightning over voltages, surge arrestors
- 6.6 VAR compensation: Real and reactive power flow through transmission line, series and shunt compensations
- 6.7 Fault calculations: Symmetrical components, grounded & ungrounded systems, L-G, L-L, L-L-G and 3-phase faults.
- 6.8 Stability studies: Steady state & transient stability limits, swing equations, equal area criterion, stability enhancement techniques.
- 6.9 Corona: corona inception voltage, power loss, waveform deformation, RI and AN due to corona

## **7 SWITCHGEAR AND PROTECTION**

- 7.1 Fuse: Types, characteristics and operating principles
- 7.2 Magnetic Contactors: Types, construction, operating principles
- 7.3 Isolators (Disconnecting switches): types, construction and operating principles
- 7.4 MCB and MCCB: Construction, operating principles, characteristics
- 7.5 Relays: Electromagnetic and Static Relays, Over current Relay, Impedance Relay, Directional Relay
- 7.6 Circuit Breakers: ACB, OCB, ABCB, VCB and SF<sub>6</sub> CB; construction, operating principles and applications
- 7.7 Protection schemes: Over current, under voltage, differential, distance protection
- 7.8 Grounding: System and equipment grounding, electric shock, safe value of current and voltages, touch and step potentials, Ground Fault Current Interrupters

## **8 AUTOMATIC CONTROL SYSTEM**

- 8.1 Mathematical modeling: differential equation representation, transfer function notations and state space representations of a physical systems.
- 8.2 Block diagram: block diagram representation of the control system components, signal flow graphs.
- 8.3 Time response: impulse response, step and ramp response analysis of a 1st and 2nd order systems, overshoot and damping concepts.
- 8.4 Steady state error: evaluation of the steady state error and error constants

## लोक सेवा आयोग

नेपाल इन्जिनियरिङ्ग सेवा, इलेक्ट्रिकल इन्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल इन्जिनियरिङ्ग उपसमूह तथा नेपाल संसद सेवा, इन्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल उपसमूह, राजपत्राङ्कित तृतीय श्रेणीको प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

- 8.5 Stability: Relative and absolute stability, Routh-Herwitz criterion.
- 8.6 Controllers: lead-lag and PID controllers.
- 8.7 Root locus: judging the relative stability and setting controller parameters of a close loop control system using root locus technique.
- 8.8 Frequency response: Polar and Bode plots, stability in frequency domain, gain margin and phase margins, controller parameters selection using frequency response.

## 9 BASIC ELECTRONICS

- 9.1 Bi-polar junction transistor: construction, operating characteristics, use as amplifier and switch.
- 9.2 Logic circuit: Decimal, Binary and Hexadecimal system, logic gates, adder, Encoder, Decoder, Multiplexer, Demultiplexer.
- 9.3 Power Electronics Devices: Thyristor, Triac, MOSFET, IGT, GTO – Construction and their characteristics
- 9.4 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.
- 9.5 DC chopper: Step down chopper, Step up chopper.
- 9.6 Inverter: Single phase voltage inverter, Three phase voltage inverter, current source inverter.
- 9.7 Cyclo-converter – Single phase and three phase.
- 9.8 AC voltage controller – with resistive load and inductive load.

## 10 UTILIZATION OF ELECTRICAL ENERGY

- 10.1 Economic considerations: Cost classification; interest and depreciation
- 10.2 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
- 10.3 Plant use factor; load sharing between base load and peak load plants
- 10.4 Tariff: objective, factors affecting tariff, types of tariff
- 10.5 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.
- 10.6 Lamps: Incandescent lamps, arc lamps, sodium discharge lamps, mercury fluorescent lamps, high pressure mercury vapor lamps
- 10.7 Electrical energy conservation and analysis.

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संसद सेवा, इन्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल उपसमूह, राजपत्राङ्कित तृतीय श्रेणीको प्रतियोगितात्मक  
लिखित परीक्षाको पाठ्यक्रम  
वस्तुगत बहुउत्तर नमूना प्रश्नहरू (Sample questions)

1. A resistance of  $10\Omega$  is connected across a supply of  $200V$ . If a resistance  $R$  is connected in parallel with the above  $10\Omega$  resistance, the current drawn from the supply is doubled.

The value of unknown resistance  $R$  is:

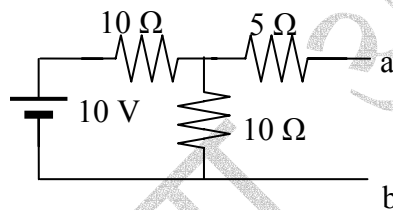
- A)  $5\Omega$
- B)  $15\Omega$
- C)  $10\Omega$
- D)  $20\Omega$

**Correct Answer Is (C)**

2. For the given circuit the Thevenin's voltage and resistance as seen at 'ab' are respectively

- A)  $5V, 10\Omega$
- B)  $10V, 15\Omega$
- C)  $10V, 10\Omega$
- D)  $5V, 15\Omega$

**Correct Answer Is (A)**



3. The terminal voltage of a dc series generator:

- A) Decreases with increase in load current
- B) Increases with increase in load current
- C) Remains constant with increase in load current
- D) Decreases by very small amount with increase in load current

**Correct Answer Is (B)**

4. Most common type of fault is

- A) L-G fault
- B) L-L fault
- C) L-L-G fault
- D) 3 phase fault

**Correct Answer Is (A)**