

लोक सेवा आयोग

नेपाल इञ्जिनियरिङ्ग सेवा, इलेक्ट्रिकल इञ्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल इञ्जिनियरिङ्ग उपसमूह तथा नेपाल संसद सेवा, इञ्जिनियरिङ्ग समूह, जनरल इलेक्ट्रिकल उपसमूह, राजपत्राङ्कित तृतीय श्रेणीको प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम
द्वितीय पत्र : इलेक्ट्रिकल इञ्जिनियरिङ्ग II

1 HYDRO POWER POLICY AND PLANING

10%

- 1.1 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.
- 1.2 Salient features of various Nepalese power plants; current scenario of transmission and distribution networks and substations in Nepal.
- 1.3 Legal provisions:
 - 1.3.1 Electricity Act, 2049
 - 1.3.2 Electricity Regulation, 2050
 - 1.3.3 NEA Act, 2041
 - 1.3.4 Civil Service Act, 2049
 - 1.3.5 Civil Service Regulation, 2050
 - 1.3.6 Hydropower Development Policy, 2058

2 NETWORK ANALYSIS

10%

- 2.1 Ohms law, Kirchoff's law, nodal and mesh analysis
- 2.2 Series and parallel circuit, delta-star and star-delta transformation
- 2.3 Concept of complex Impedance and Admittance RLC series and parallel circuit
- 2.4 Network Theorem: Thevenins theorem, Nortons theorem, Superposition theorem, Reciprocity theorem and Maximum power transfer theorem.
- 2.5 Resonance in series and parallel RLC circuit
- 2.6 Active, Reactive and Apparent power
- 2.7 Transient response of RLC circuit excited by DC and AC sources
- 2.8 Fourier analysis
- 2.9 Two-port network: Z, Y, T and h parameters, T to Π and Π to T transformation, two-port network connection
- 2.10 Three-phase circuit analysis, phase and line quantities

3 STATIC AND DYNAMIC ELECTRICAL MACHINES

10%

- 3.1 Transformer: Working principle, Equivalent Circuit, Losses and efficiency, Voltage regulation, Transformer tests, Auto transformer, Three phase transformer connections, Parallel operation
- 3.2 D.C. Machine: Constructional detail, Operation in motoring and generating mode, Back emf in DC motor, Types of DC motor, their characteristics and applications, DC motor starter, Speed control of DC motor
- 3.3 Induction machine: 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
- 3.4 Synchronous machine: Salient pole and cylindrical rotor construction, generating and motoring principle, phasor diagram and power angle characteristics, Parallel

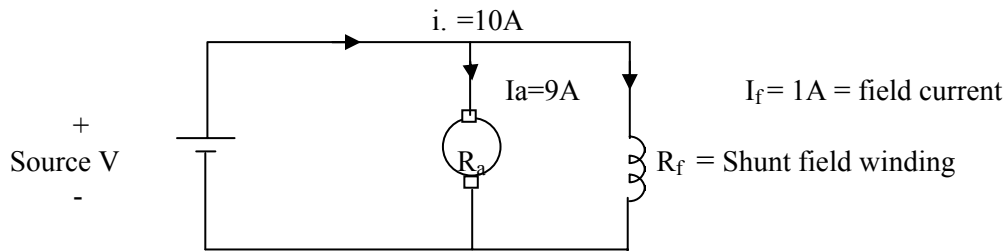
operation of synchronous generators, Starting methods for synchronous motor, Effect of excitation, V and Inverted V curves, Synchronous condenser

- 4 MEASUREMENTS AND INSTRUMENTATION 10%**
- 4.1 Accuracy, Precision, Absolute and Relative Errors, Parallax
 - 4.2 Deflection type measuring instruments: Galvanometer, Ammeter, Voltmeter, Wattmeter, Watt-hour meter, Maximum Demand Meter, Frequency Meter
 - 4.3 Instrument Transformers: Operating Principles of Measuring and Protection type CTs, Potential transformers
 - 4.4 Transducers: Tachometer, potentiometer, Measurement of electrical, mechanical, thermal and hydraulic variables
 - 4.5 Measurement of low medium and high resistances by Ohmmeter method, Meggers and DC bridges
 - 4.6 Measurement of inductance, capacitance and frequency by AC bridge circuits
 - 4.7 Operational Amplifier: Signal Amplification, attenuation, differentiation, integration and adder
 - 4.8 Operating principles of Analog and Digital Oscilloscope
 - 4.9 Analog to Digital and Digital to Analog converters
 - 4.10 Digital instrumentation: Fundamental principles, interfacing to the computers, Microprocessor based instrumentation
- 5 ELECTRICAL SUPPLY SYSTEMS 10%**
- 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 POWER SYSTEM ANALYSIS 10%**
- 6.1 Computation of transmission line parameters, GMD and GMR, proximity effect and skin effect.
 - 6.2 Transmission line performance: Per unit system representation, Single line diagram, Lumped and distributed parameter modeling, ABCD parameters, efficiency & regulations calculations, Ferranti effect, surge impedance loading
 - 6.3 Load flow: Basic Load flow equation, Gauss-Seidal and Newton-Raphson methods
 - 6.4 Over voltages in transmission lines: Power frequency, switching and lightning over voltages, surge arrestors
 - 6.5 VAR compensation: Real and reactive power flow through transmission line, series and shunt compensations
 - 6.6 Fault calculations: Symmetrical and unsymmetrical faults
 - 6.7 Power system stability studies: Steady state & transient stability limits, swing equations, equal area criterion, stability enhancement techniques.
 - 6.8 Corona: corona inception voltage, power loss, waveform deformation, RI and AN due to corona
- 7 POWER SYSTEM PROTECTION 10%**

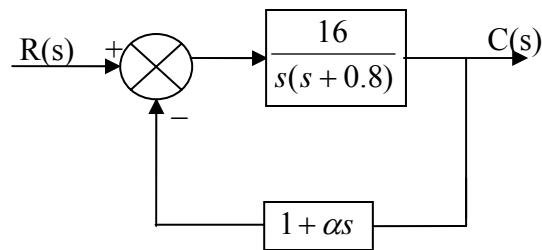
- 7.1 Fuse, Magnetic Contactors, Isolators, MCB and MCCB: characteristics and operating principles
- 7.2 Relays: Electromagnetic and Static Relays, Over current Relay, Impedance Relay, Directional Relay
- 7.3 Circuit Breakers: ACB, OCB, ABCB, VCB and SF₆ CB; construction, operating principles and applications
- 7.4 Protection schemes: Over current, 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
- 8 CONTROL SYSTEM 10%**
- 8.1 Mathematical modeling: differential equation representation, transfer function notations and state space representations of physical systems, Block diagram algebra, signal flow graphs.
- 8.2 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
- 8.3 Effect of feedback on stability and steady state error
- 8.4 Stability: Relative and absolute stability, Routh -Herwitz criterion.
- 8.5 Root locus: Manual plotting and judging the relative stability using root locus technique.
- 8.6 Frequency response: Polar, and Bode plots, stability in frequency domain, gain margin and phase margins, Nyquist criterion for stability.
- 8.7 Root locus: Manual plotting and judging the relative stability using root locus technique.
- 8.8 Control system design: lead-lag and PID controllers and setting the controller parameters using Root locus and Bode plots.
- 9 POWER ELECTRONICS 10%**
- 9.1 Devices: Power Transistor, Power Diodes, Thyristor, Triac, MOSFET, UJT, GTO – Construction and their characteristics
- 9.2 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.
- 9.3 DC chopper: Step down chopper, Step up chopper.
- 9.4 Inverter: Single phase voltage inverter, Three phase voltage inverter, current source inverter.
- 9.5 Cyclo-converter – Single phase and three phase.
- 9.6 AC voltage controller – with resistive load and inductive load.
- 10 ECONOMICS OF POWER UTILIZATION 10%**
- 10.1 Economic considerations: Cost classification; interest and depreciation
- 10.2 Demand 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 Tariff: objective, factors affecting tariff, types of tariff
- 10.4 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. Incandescent lamps, arc lamps, sodium discharge lamps, mercury fluorescent lamps, high pressure mercury vapor lamps.

विषयगत नमूना प्रश्नहरू (Sample Questions)

1. A three phase star connected system with line voltage of 400V connected to three loads: $25\angle 0^\circ$, $11\angle -20^\circ$ and $15\angle 10^\circ \Omega$. Find current through neutral and total power of the circuit.
2. The following figure shows the circuit diagram of a dc shunt motor running at 1500 rpm and drawing a current of 10 A from the source. If the field winding is disconnected, explain what will happen to the operation of the motor?



3. A 1100V/ 110V single phase transformer draws a current of 0.75 amp and consumes 300 watt at no-load. When a low voltage of 60 V is applied at primary with secondary terminals short circuited, primary draws a current of 16A and consumes 600 watts. Calculate the equivalent circuit parameters refer to primary side.
4. Consider the close loop control system as shown in figure bellow. Determine the value of α such that the damping ratio is 0.5. Also determine the maximum overshoot in its step response.



5. Explain the operation of a single phase ac voltage controller with resistive load with a neat circuit diagram.