द्वितीय पत्र (Paper II): Technical Subject

Section A -20 Marks

1. HYDRO POWER POLICY AND PLANING

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
- 1.3.2 Electricity Regulation
- 1.3.3 NEA Act
- 1.3.4 Civil Service Act
- 1.3.5 Civil Service Regulation
- 1.3.6 Hydropower Development Policy

2. ECONOMICS OF POWER UTILIZATION

2.1 Economic considerations: Cost classification; interest and depreciation

2.2 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

2.3 Tariff: objective, factors affecting tariff, types of tariff

2.4 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.

Section B-20 Marks

3. NETWORK ANALYSIS

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

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

3.3 Concept of complex Impedance and Admittance RLC series and parallel circuit

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

3.5 Resonance in series and parallel RLC circuit

3.6 Active, Reactive and Apparent power

3.7 Transient response of RLC circuit excited by DC and AC sources

3.8 Fourier analysis

3.9 Two-port network: Z, Y, T and h parameters, T to Π and Π to T transformation, two-port network connection

3.10 Three-phase circuit analysis, phase and line quantities

4. CONTROL SYSTEM

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

4.2 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

4.3 Effect of feedback on stability and steady state error

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

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

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

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

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

Section C-30 Marks

5. STATIC AND DYNAMIC ELECTRICAL MACHINES

5.1 Transformer: Working principle, Equivalent Circuit, Losses and efficiency, Voltage regulation, Transformer tests, Auto transformer, Three phase transformer connections, Parallel operation

5.2 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

5.3 Induction machine: Equivalent circuit, Torque-speed characteristic, Losses and efficiency, Staring methods, Speed control of three phase induction motor, Induction motor tests, Single phase induction motors- types, characteristics and applications

5.4 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

6. ELECTRICAL SUPPLY SYSTEMS

6.1 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

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

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

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

7. POWER SYSTEM ANALYSIS

7.1 Computation of transmission line parameters, GMD and GMR, proximity effect and skin effect.

7.2 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

7.3 Load flow: Basic Load flow equation, Gauss-Seidal and Newtan-Rapshon methods

7.4 Over voltages in transmission lines: Power frequency, switching and lightning over voltages, surge arrestors

7.5 VAR compensation: Real and reactive power flow through transmission line, series and shunt compensations

7.6 Fault calculations: Symmetrical and unsymmetrical faults

7.7 Power system stability studies: Steady state & transient stability limits, swing equations, equal area criterion, stability enhancement techniques.

7.8 Corona: corona inception voltage, power loss, waveform deformation, RI and AN due to corona

Section D-30 Marks

8. MEASURMENTS AND INSTRUMENTATION

8.1 Accuracy, Precision, Absolute and Relative Errors, Parallax

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

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

8.4 Transducers: Tachometer, potentiometer, Measurement of electrical, mechanical, thermal and hydraulic variables

8.5 Measurement of low medium and high resistances by Ohmmeter method, Meggers and DC bridges

8.6 Measurement of inductance, capacitance and frequency by AC bridge circuits

8.7 Operational Amplifier: Signal Amplification, attenuation, differentiation, integration and adder

8.8 Operating principles of Analog and Digital Oscilloscope

8.9 Analog to Digital and Digital to Analog converters

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

9. POWER SYSTEM PROTECTION

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

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

9.3 Circuit Breakers: ACB, OCB, ABCB, VCB and SF6 CB; construction, operating principles and applications

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

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

10. POWER ELECTRONICS

10.1 Devices: Power Transistor, Power Diodes, Thyristor, Triac, MOSFET, UJT, GTO – Construction and their characteristics

10.2 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.

10.3 DC chopper: Step down chopper, Step up chopper.

10.4 Inverter: Single phase voltage inverter, There phase voltage inverter, current source inverter.

10.5 Cyclo-converter – Single phase and three phase.

10.6 AC voltage controller – with resistive load and inductive load.

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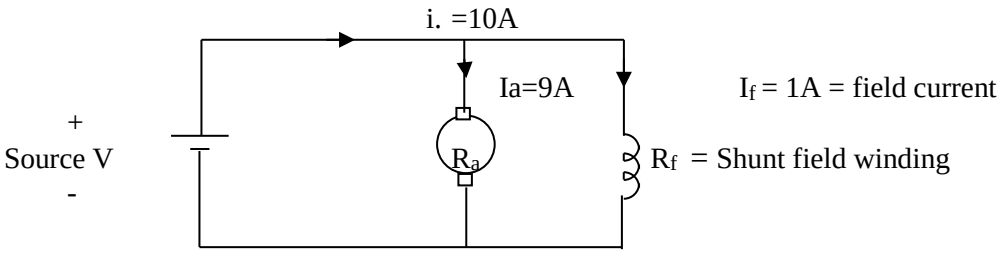
विषयगत नमूना प्रश्नहरु (Sample Questions)

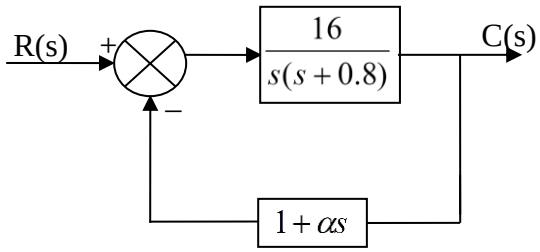
1. A three phase star connected system with line voltage of 400V connected to three loads: $25\angle 0^{O}$, $11\angle -20^{O}$ and $15\angle 10^{O}\ \Omega$. Find current through neutral and total power of the circuit.

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.

प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई 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 नेताविहिन सामूहिक छलफल (Leaderless Group Discussion) को रुपमा अवलम्वन गरिने छ । दिइएको प्रश्न वा Topic का विषयमा पालैपालोसँग निर्दिष्ट समयभित्र समूहवीच छलफल गर्दै प्रत्येक उम्मेदवारले व्यक्तिगत प्रस्तुति (Individual Presentation) गर्नु पर्नेछ । यस परीक्षणमा मूल्याङ्कनको लागि देहाय अनुसारको ३ जनाको समिति रहनेछ ।

आयोगका अध्यक्ष वा 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 ।