RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SYLLABUS OF COMPETITIVE EXAMINATION FOR THE POST OF ASSISTANT ELECTRICAL INSPECTOR (ENERGY DEPARTMENT)

1 **Electrical Circuit Analysis :**

Circuit Elements, Voltage and Current Source, dependent Source, Kirchoff's laws, Mesh & Nodal analysis, Electric & magnetic fields in dielectric, conductors and magnetic materials, Network Theorems and their applications. Natural response and forced response, Transient response and steady state response for arbitrary inputs, Transient analysis using Laplace transformation, Properties of networks in terms of poles and zeros, Transfer functions, Resonant Circuits, three phase circuits, two port networks, Elements of two-element network synthesis.

2 **Measurements and Instrumentation:**

General Principal of measurement, Error analysis, Measurements of current, voltage, power, power factor and energy. Indicating instruments. Measurements of resistance, inductance, capacitance and frequency, Bridge measurements, Electronic measurement instruments, Digital voltmeter and frequency counters. Transducers and their applications to the measurement of non-electrical quantities like – temperature, pressure, flow rate, displacement, acceleration, A/D & D/A converters.

3 **Electrical Machines:**

DC generators: Construction, Types of DC generators, emf equation, equalizing connections, armature reaction, commutation, methods of improving commutations, demagnetizing and cross magnetizing mmf, interpoles, characteristics.

DC Motors: Principle, back emf, types, production of torque, armature reaction & interpoles, characteristics of shunt, series & compound motor, DC motor starting. Speed Control of DC Motor: Armature voltage and field current control methods, Braking, losses and efficiency, single-phase series motor.

Transformers: Construction, types, emf equation. No load and load conditions. Equivalent circuits, Vector diagrams, OC and SC tests, efficiency. Voltage regulation, effect of frequency, parallel operation, autotransformers, polyphase transformer: Principle, working & connection diagrams. Transformer connection for 3-phase operation – star/delta, delta/star, zig-zag/star and V/V, comparative features.

Induction Motors: Construction of squirrel cage & slip ring induction motor, basic principles, flux and mmf waves. Equivalent circuits, torque equation, torque-slip curves, no load & block rotor tests. Effect of rotor resistance. Cogging, Crawling.

Starting & Speed Control of Induction Motors: Various methods of starting & speed control of squirrel cage & slip ring motor, braking.

Single-Phase Machine: Single phase Induction Motor, Constructional features, Double revolving field theory, equivalent circuit, starting methods and applications, single-phase synchronous motors, series motor, universal motor.

Synchronous Generator: Construction, types, excitation systems, principles. Equation of induced emf, flux and emf waves, theory of cylindrical rotor and salient pole machines, synchronization, parallel operation, hunting and its prevention.

Synchronous Motors: types, construction, principle, phasor diagrams, speed torque characteristics, power factor control, V-curves, starting methods, performance calculations, applications, synchronous condenser, synchronous induction motor.

Special Machines: Construction, principal of working and characteristics of brush less DC Machine (BLDC), switched reluctance motor (SRM), stepper motor, permanent magnet synchronous machine, double fed induction generator (DFIG).

4 **Power System:**

Generation of Electrical power and Supply System: Solar, Wind, Biomass, Thermal, Hydro and Nuclear power plants. Transmission and distribution voltage, effect of system voltage on size of conductor and losses. Comparison of DC 2- wire, DC 3- wire, 1- phase AC and 3- phase AC (3- wire and 4- wire) systems. Primary and secondary distribution systems, feeder, distributor and service mains. Radial and ring- main distribution systems.

Parameters of Transmission Lines: Resistance inductance and capacitance of overhead lines, effect of earth, line transposition. Inductance and capacitance of line with symmetrical and unsymmetrical spacing Inductance and capacitance of double circuit lines. Skin and proximity effects. Equivalent circuits and performance of short and medium transmission lines**.** Generalized ABCD line constants, equivalent circuit and performance of long transmission line. Ferranti effect. Interference with communication circuits. Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona. Corona power loss. Effects of corona.

Insulators and Underground Cables: Types of insulators. Voltage distribution across an insulator string, grading and methods of improving string efficiency. Types of underground cables. Insulator resistance and capacitance calculation. Causes of breakdown. Thermal rating of cable.

Distribution Systems: Distribution of power, power loads. Load survey, load forecasting-regression analysis, correlation theory, analysis of time series, load growth factors.

Protection: Method of fault analysis, circuit breakers and isolators. Overcurrent (OC) relays – instantaneous, definite time, inverse time and inverse definite minimum time overcurrent relays, time and current gradings. Induction disc type relay. Directional overcurrent relay. Earth fault relay. Brief description of overcurrent protective schemes for a feeder, parallel feeders and ring mains. Generator Protection**:** Stator protection – differential and percentage differential protection, protection against stator inter-turn faults, stator overheating protection. Rotor protection against excitation and prime mover failure. Transformer Protection**:** Percentage differential protection, magnetizing inrush current, percentage differential relay with harmonic restraint. Buchholz relay. Differential protection of generator transfer unit. Busbar Protection**:** Differential

protection of busbars, high impedance relay scheme, frame leakage protection. Transmission Line Protection**:** Introduction to distance protection. Impedance relay. Effect of arc resistance. Induction cup type reactance and mho relays. Comparison between impedance, reactance and mho relays. Three stepped distance protection of transmission line.

Grounding: Grounding system, earth and safety, earth electrode- earth resistance calculation, effect of rod size and soil resistivity, earth conductor sizes. Introduction to earth electrode design. Brief description of system earthing – system neutral earthing, earthing of substations, lines and consumer premises. Earth fault protection of feeders.

Electric Heating and Welding: Different methods of electric heating. Principle of high frequency induction and di-electric heating. Welding process, welding transformer, Classification of Electric welding.

Illuminations: Definitions, laws of illuminations, polar curves, luminous efficiency, photometer, LED lamps, Light calculations of commercial, industrial, street and flood lighting.

5 **Control System Engineering:**

Open loop and closed loop systems, Transfer function, Time response and steady state analysis, stability R- H criteria, Nyquist criteria, relative stability analysis, bode plot and Root locus methods, frequency response, control system components, State variable analysis, a-c and d-c servo motor and techogenerator.

6 **Power Electronics:**

Construction operation and characteristics of power semiconductor devices: power diode, power transiter, power IGBT, MOSFET, MCT, DIAC, TRIAC, Principles of operation of Thyristors, Rectifiers, Invertors and Choppers. Methods of speed control of motors using SCR's. Principal of PWM control.

7 **Micro Processor and C-Programming:**

Micro processor architecture (8085): Functional block diagram, Buses, Introduction to circuits (Block diagram only) used in electrical application. Introduction of 'C' language, Elements of 'C', Arrays, Functions and Pointers.

Pattern of Question Papers:

1. Objective Type Paper
2. Maximum Marks: 150
3. Number of Questions: 150
4. Duration of Paper: 2.30 Hours
5. All Questions carry equal marks
6. There will be Negative Marking

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