Department of Electrical Engineering

Syllabus for Ph. D Entrance Examination – Autumn, 2021

1. **Electric Machines:-**

   i. Transformers: Construction, Detailed Analysis, Equivalent circuit diagram, pharos diagram, efficiency, voltage regulation, analysis of three-phase transformers, transformer tests, instrument transformers.

   ii. D.C Machines: Principle of operation, emf and torque equations, equivalent and circuits, types of DC machines, DC Generator characteristics, parallel operation, DC Motor Torque speed characteristics, Speed control techniques, DC motor starting, Applications.

   iii. Induction Machines: Operating principle, Torque equation, Equivalent circuit, no-load and blocked rotor tests, torque speed characteristics, Speed – control techniques, starting, Applications, Induction generator,

   iv. Synchronous Machines: Voltage equation, windings, tests, characteristics, application, synchronous motor starting, V-curves, Synchronous condenser.

2. **Power Systems:**

   Introduction to Power System generation, transmission and distribution. Element of AC distribution, Single fed, double fed and ring main distributor. Transmission line parameters and their evaluations, types of overhead conductors with calculations of inductance and capacitance. Models of short, medium and long transmission lines, skin, proximity and Ferranti effect. Classification of cables, Cable conductor's, insulating materials, insulation resistance, grading of cables,,

   Per unit Representation of power Systems: Fault Analysis (Balanced Faults): Faults, types of faults, symmetrical 3-phase balanced faults, calculation of fault currents, current limiting reactors. Fault Analysis, (unsymmetrical faults) Symmetrical components, sequence impedances, sequence networks, unsymmetrical faults-single line to ground, line to line, double line to ground faults on unloaded alternators and on power systems. Insulation Co-ordination. Surge performance of Transmission lines: Traveling waves on transmission lines, open-end line, short-circuited line, line terminated through a resistance, line connected to a cable. Interference of Power Lines with communication Circuit.

   Load Flows: Nature and importance of the problem, Network model formulation, algorithm for the formulation of Ybus matrix, formulation of Ybus by singular transformation, primitive network, Bus incidence matrix, load flow problem, load flow equations, bus classification, gauss – seidel & Newton-Raphson method for

solving load flow problem, Power System Stability: The stability problem, steady state, dynamic and transient stability, rotor dynamics and swing equation, power-angle curve, equal-Area criterion of stability, Numerical solution of swing equation, Factors affecting transient stability, Automatic Generation Control: Real power balance and its effect on system frequency, load frequency control of single area system-speed governing system. Control of voltage and Reactive Power: Methods of voltage control-injection of reactive power, tap changing transformers, booster transformers, phase-shift transformers. Economic Operation of Power System. Power System protection, Over current, overvoltage, Differential protection, Distance relays.

3. Electrical Measurements & Instrumentation

Electro-mechanical indicating instruments, Classification, effects utilized in measuring instruments, errors and their types, various methods of damping, galvanometers (D' Arsenal and Ballistic) Ammeters and Voltmeters (PMMC, Induction, electrostatic and Dynamometer type), errors in voltmeters and ammeters, extension of instrument range, ammeter shunts, voltmeter multipliers, Measurement of Power, Energy and Power Factor Measurement of reactive power (single phase and 3-phase), Energy measurement using induction type classification, Wheatstone bridge, Meggar, Measurement of inductance, Capacitance and Frequency using a. c bridges, Potentiometers; D.C instrumentation: Introduction of virtual instrumentation. Measurement of Electrical and non-electrical quantitates using virtual instruments control System.

Renewable Energy: Solar, wind and Hybrid.

4. **Power Electronics**

Power semiconducting devices, characteristics, snubber circuits, Gate drive circuits, series and parallel operations of Thyristors, single-phase and three phase uncontrolled and controlled rectifiers, DC-DC converters (Continuous and Discontinuous conduction modes of operation), AC voltage controllers, Cycloconverters , Inverter, Pulse Width Modulation Techniques, Variable-frequency Induction motor drives, Converter-Fed DC Motor Drives, Chopper-Fed DC Motor Drives, Electric Drives, Applications of Power Electronics.

5. **Circuit Analysis:**

i. D.C circuit Analysis: series and parallel resistor, KCl, KVL, circuit theorems, Nodal analysis, Mesh current analysis.

ii. A.C circuit Analysis: R, L, C, R-L, R-C, L-C, R-L-C (series and parallel) circuits excited by sinusoidal AC, Application of KCL. KVL and circuit theorem, series and parallel resonance, Power in AC circuits, concept of power factor and p.f improvement.

6. **Control Systems**

Introduction of continuous control systems: Open-loop, closed loop (automatic and manual) control, Mathematical modeling: Transfer functions, block diagrams, signal flow graphs. First and second order system: sample of first and second order systems, responses of theirs systems to step, ramp, parabolic and sinusoidal inputs, transient, steady state and error analysis, Stability studies: stability and pole locations, stability and Routh Table, stability and frequency response bode plot, polar plot, Nyquist's criterion, root locus, proportional , integral, Derivative (P.I.D) control, state variable modeling Digital control system: Hardware elements of a digital control system, Z – transform, Nonlinear control systems. Linearization of Non-linear control system about and nominal operating point, analysis and design using linearized models.

7. Engineering Mathematics:

Linear Algebra, Matrix Algebra, Eigen values and Eigen vectors, calculus, partial derivatives, total derivative, Taylor series, Fourier series, Laplace transformations. Complex variables, Cauchy-Riemann equation, Numerical methods.

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Head of the Department