Item No. - 130
AC- 23/7/2020

University of Mumbai
Syllabus for PET- 2020 Examination
Subject: Electrical Engineering

Section A: Research Methodology and General Awareness

1.0 **Introduction and Basic Research Concepts**
- **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology
- **1.2** Need of Research in Business and Social Sciences
- **1.3** Objectives of Research
- **1.4** Issues and Problems in Research
- **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical

2.0 **Types of Research**
- **2.1** Basic Research
- **2.2** Applied Research
- **2.3** Descriptive Research
- **2.4** Analytical Research
- **2.5** Empirical Research
- **2.6** Qualitative and Quantitative Approaches

3.0 **Research Design and Sample Design**
- **3.1** Research Design – Meaning, Types and Significance
- **3.2** Sample Design – Meaning and Significance Essentials of a good sampling, Stages in Sample design
- **3.3** Sample Design Sampling methods/techniques Sampling Errors

4.0 **Research Methodology**
- **4.1** Meaning of Research Methodology
- **4.2** Stages in Scientific Research Process:
  - **a.** Identification and Selection of Research Problem
  - **b.** Formulation of Research Problem
  - **c.** Review of Literature
  - **d.** Formulation of Hypothesis
  - **e.** Formulation of research Design
  - **f**. Sample Design
  - **g.** Data Collection
  - **h.** Data Analysis
  - **i.** Hypothesis testing and Interpretation of Data
  - **j.** Preparation of Research Report

5.0 **Formulating Research Problem**
- **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis

6.0 **Outcome of Research**
- **6.1** Preparation of the report on conclusion reached
- **6.2** Validity Testing & Ethical Issues
- **6.3** Suggestions and Recommendation

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Section B: Electrical Engineering

Engineering Mathematics	**(Weightage = 10%)**

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green's theorem.

***Differential equations*:** First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.

Complex variables: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor series, Laurent series, Residue theorem, Solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.

***Numerical Methods*:** Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations.

Electric Circuits and Electronics	**(Weightage = 20%)**

Electric Circuits and Measurements: Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits. Bridges and Potentiometers, measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement

Analog and Digital Electronics: Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, De-multiplexer, Schmitt trigger, ADC and DAC; Basics of Micro-processors and Microcontrollers.

Signals and Systems: Representation of continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform.

Electromagnetics and Electric Machinery	**(Weightage= 20%)**

Electromagnetic Fields: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magneto-motive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Electrical Machine: Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

Power Systems and Renewable Energy (Weightage = 25%)

Power Systems: Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Renewable Energy and Energy Storage: Renewable energy sources: Solar photovoltaic (PV) and Wind Energy; Off grid and grid-tied system; Characteristics and performance analysis of Energy Storage: Battery, ultracapacitor and Fuel cell, Smart grid and microgrid Concepts

Control Systems and Power Electronics (Weightage = 25%)

Control Systems: Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Power Electronics: Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; Si, SiC and GaN devices; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Single phase and three phase inverters, Sinusoidal pulse width modulation; Control of converters and inverters, current control and voltage control.

References Books:

1. Modern Power System Analysis 4th Edition D.P. Kothari, I.J. Nagrath Tata McGraw Hill
2. Control System Analysis by Nagrath Gopal, New Age International Publisher.
3. Modern Control System Engineering by K.Ogata, Prentice Hall Publication India.
4. Fundamentals of Power System Protection- Y. G Paithankar & S. R Bhide
5. Power System Protection (Vol. I, II & III) by Warrington
6. Art and Science of Protective Relaying by C.R Mason
7. Non-Conventional Energy Sources by B.H.Khan Mc Graw Hill Electrical Power System Planning by A.S. Pabla, Macmillan India Ltd.
8. Power Electronics, Ned Mohan, T. M. Udeland, William P. Robbins, John Wiley & sons.
9. Power System Analysis: Arthur R. Bergen, Vijay Vithal, Pearson Education Asia
10. Power System Stability and Control: Kundur, P., McGraw Hill Inc., (1994)

****