Item No. 131

AC-23/07/2020

UNIVERSITY OF MUMBAI

Syllabus for PET- 2020 Examination

for

Instrumentation Engineering

FACULTY OF SCIENCE & TECHNOLOGY

University of Mumbai

Syllabus for PhD PET July 2020 Subject:

Instrumentation Engineering

Section A: Research Methodology and General Awareness

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** Issuesand 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, (2^{nd}ed), Singapore, Pearson Education

Instructions:

- PET Examination will be of Total Marks =100
- Candidates can attempt any one specialisation as mentioned in the A or B or C as given below:

Section B: Instrumentation Engineering

Electrical Circuits:

Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, mutual inductor and capacitor; transient analysis of RLC circuits with dc excitation.
Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems. Peak-, average- and rms values of ac quantities; apparent-, active- and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements.One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters.

Analog Electronics

Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits. Oscillators, signal generators, voltage controlled oscillators and phase locked loop.

Digital Electronics

Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip- flops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to- digital (successive approximation, integrating, flash and sigma-delta) and digital-to- analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems, 8-bit microprocessor and microcontroller: applications, memory and input-output interfacing; basics of data acquisition systems.

Measurements

SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

Sensors and Industrial Instrumentation

Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement.

Signals and Systems

Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; convolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

Control Systems

Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, P-I, P-I-D, cascade, feedforward, and ratio controllers.

Communication and Optical Instrumentation

Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing, amplitude-, phase-, frequency-, pulse shift keying for digital modulation; optical sources and detectors: LED, laser, photo-diode, light dependent resistor and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing.

References:

1. A. K. Sawhney, Puneet Sawhney,2012 “A course in Electrical and Electronic Measurement and Instrumentation”, DhanpatRai and Co. Rai.
2. C. D. Johnson,2016 “Process Control Instrumentation Technology”, Pearson.
3. Norman S. Nise, 2000 “Control Systems Engineering”, John Wiley and Sons.
4. Oppenheim, Willsky, S.Hamid Nawab,2002, “Signals and Systems” PHI,2nd edition.
5. Ramakant A. Gaikwad, 2002, “Op-amp and Integrated circuits”, Fourth edition, PHI Publication.
6. Gerd Keiser, 2017 “Optical Fiber Communication” (SIE) 5th Edition.