

**Department of Instrumentation Engineering**  
**H. N. B. Garhwal University Srinagar Garhwal**

**Syllabus of subject specific component of entrance examination for admission in Doctor of Philosophy (Ph.D.) programme in Instrumentation Engineering**

**Section 1: Electrical Circuits and Machines**

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

DC and AC machines: Constructing features and principles of operation of DC generator and DC motor; separately excited, shunt and compound types of DC field excitations; torque-speed characteristics of separately excited, shunt, series and compound motors; starting, speed control and braking of DC motors. Equivalent circuit, phasor diagram, open circuit and short circuit tests of transformer, regulation, losses and efficiency of transformer. Principle of operation, types, performance, torque-speed characteristics, equivalent circuit, starting, and speed control of single-phase induction motor.

**Section 2: 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.

**Section 3: 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; discontinuous, continuous and composite controller modes, on-off, P, PI, PID controllers, electronic controllers, tuning of PID controllers, cascade, feed forward, and ratio controllers, control valve characteristics, types, sizing of control valves, cavitations and flashing.

#### **Section 4: Analog Electronics and Signal Conditioning**

Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of ideal and practical operational amplifiers; applications of op-amps: adder, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier, precision rectifier, active filters, oscillators, signal generators, voltage-controlled oscillators and phase locked loop, sources and effects of noise and interference in electronic circuits.

#### **Section 5: Digital Electronics and Programmable Devices**

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, Embedded Systems: Microprocessor and microcontroller applications, memory and input-output interfacing; basics of data acquisition systems, basics of distributed control systems (DCS) and programmable logic controllers (PLC).

#### **Section 6: Measurements**

Systematic and random errors in measurement, expression of uncertainty - accuracy and precision, propagation of errors, linear and weighted regression. Bridges: Wheatstone, Kelvin, Megohm, Maxwell, Anderson, Schering and Wien for measurement of R, L, C and frequency, 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.

#### **Section 7: 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 (variable head, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters), temperature (RTD, thermistor, thermocouple, pyrometer), humidity and moisture, viscosity and consistency, density and specific gravity, and liquid level measurement.