SARVAJANIK UNIVERSITY

SARVAJANIK COLLEGE OF ENGINEERING AND TECHNOLOGY

Instrumentation & Control Engineering

SU Ph.D Entrance Test Syllabus

Syllabus for Ph.D. Entrance Test in INSTRUMENTATION & CONTROL Engineering

Section 1: Engineering Mathematics

Mathematics: limits, differential and integral calculus, ordinary and partial differential equations, calculus of variations, convex optimization.

Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition, finite dimensional vector spaces, null space, linear dependency of vectors, basis of vector space, orthogonal basis, adjoint, determinants, linear transformation.

Signals and Systems: Periodic, aperiodic and impulse signals; types of systems 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 2: Basics of Electrical Engineering

Voltage and current sources: independent, dependent, ideal and practical; V-I relationships of resistor, inductor, mutual inductance and capacitor; transient analysis of RLC circuits. Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer 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.

Section 3: Basics of Electrical Machines

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 4: Basics of Electronics Engineering

Circuit design and analysis, diodes, types of diodes, npn and pnp transistors, transistor biasing, transistor amplifiers, JFET, MOSFET, IGBT and their applications. Operational amplifiers, Instrumentation amplifier, feedback, Op-Amp circuits for various real applications, oscillators and signal generators, voltage controlled oscillators, 555 and 566 timer ICs, Phase locked loop.

Section 5: Digital Logic Boolean algebra and microcontrollers

Combinational and sequential circuits. K maps, Minimization. Number systems, representations and computer arithmetic (fixed and floating point), ADC and DAC basics, resolution, quantization of ADC, types of ADC and DAC. flip flops, shift register, memory and its types, microcontrollers and microprocessors basics, architecture and programming with assembly and embedded C., basic concepts of programming timers and ADCs, UART/USART.

SARVAJANIK UNIVERSITY

SARVAJANIK COLLEGE OF ENGINEERING AND TECHNOLOGY

Instrumentation & Control Engineering

SU Ph.D Entrance Test Syllabus

Section 6: Industrial Measurement and Measuring Instruments

Systematic and random errors in measurement, expression of uncertainty - accuracy and precision, propagation of errors, linear and weighted regression. Bridges: Wheatstone, Kelvin, Hay's, Maxwell, Anderson, Schering and Wien for measurement of R, L, C and frequency, Q-meter. Measurement of voltage, current, energy 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: Process Istrumentation

Resistive, capacitive, inductive, piezoelectric sensors, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), speed/velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure/vacuum), 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, pH measurement, gas and liquid chromatography, mass spectrometry, oxygen and carbon dioxide gas analysers.

Section 8: Control Systems

Feedback principles, signal flow graphs, transient response, steady-state-errors, concepts of stability, BIBO stability, Routh and Hurwitz criteria, , root locus, Bode plot, phase and gain margins ,design of lead, lag and lead-lag compensators, state-space representation of systems; controllability, observability and pole placement, observer design, regulation, tracking of standard reference inputs, discontinuous, continuous and composite controller modes, on-off, P, PI, PID controllers, electronic controllers, tuning of PID controllers, Nyquist plots, Nichols chart. Linear and non-linear systems, Lyapunav stabilty criteria, optimization, minimum principle, finding local and global equilibrium states, Krasooviski's method, Introduction to optimal control, Formulation of optimal control problems, calculus of variations, fundamental concepts, functional, variation of functional, fundamental theorem of theorem of Calculus of variations, boundary conditions, constrained minimization, formulation using Hamiltonian method, Riccatti equation, Linear Quadratic Regulators, robust control systems.

Section 9: Process Control and Automation

control valve characteristics, types, sizing of control valves, cavitations and flashing, valve positioners, pneumatic systems, E/P(I/P) –Electrical to Pneumatic converter and P/E(P/I) converters, Process identification (first and second order system models) and Process control, time constant, dead time and self regulation of processes, interaction and non-interacting systems, inverse response of systems, smith predictor, boilers and three element control, heat exchanger control, multivariable control, Relative Gain Array, cascade control, feed-forward and ratio control, model predictive control, PID controllers, Zieglar Nichols settings, integrator windup & anti-windup systems, PID controller position and velocity algorithms, bumpless transfer, Basics of Programmable Logic Control(PLC) and Distributed Control Systems (DCS), DCS topology, Supervisory Control and Data Acquisition(SCADA). Ladder programming basics, Industrial Data Communications, MODBUS, RS 485 and HART protocol.