ELECTRONICS AND INSTRUMENTATION ENGINEERING

& INSTRUMENTATION AND CONTROL ENGINEERING

UNIT 1: ENGINEERING MATHEMATICS

Matrix – characteristic equation – eigen values and eigen vectors – Cayley – Hamilton theorem - partial derivatives – maxima and minima – linear differential equations with constant coefficients - linear first order simultaneous equations with constant coefficients – Taylor and Laurent expansions - residue theorem – Laplace transform – initial and final value theorems – inverse Laplace transform - Fourier series and Fourier transforms – solution of standard types of first order partial differential equations – z-transform - inverse z-transform – convolution theorem.

UNIT 2: CIRCUIT THEORY

Mesh current and node voltage methods of analysis – network reduction and network theorems – voltage and current division, source transformation – star delta conversion - Thevenin's and Norton's theorems – superposition theorem – maximum power transfer theorem – series and parallel resonance - frequency response – quality factor and bandwidth – self and mutual inductance - transient response for dc and sinusoidal inputs – analysis of three phase 3-wire and 4-wire circuits - power and power factor measurements in three phase circuits.

UNIT 3: ANALOG AND DIGITAL ELECTRONICS

Diode, BJT, JFET, MOSFET – characteristics and parameters – biasing - h parameters - amplifiers - frequency response – RC coupled amplifier – power amplifiers - feedback amplifiers - oscillators - wave shaping circuits – single and polyphase rectifiers – filters – design of Zener and transistor series voltage regulators - op-arnp characteristics – frequency response - summer, integrator, instrumentation amplifier, first and second order active fitters,V/I and I/V converters, comparators, waveform generators, peak detector, S/H circuit, *D/A* converter (R-2R ladder and weighted resistor types),A/D converter – dual slope, successive approximation and flash types – isolation amplifiers, opta-coupler.

Boolean algebra - De-Morgan's theorems – simplification using K-maps and Quine McCluskey Method – logic gates – design of arithmetic circuits - encoders, decoders, multiplexers and demultiplexers – flip flops - counters – shift registers – design of synchronous and asynchronous sequential circuits. Design of sequential networks

using PAL, PLA – FPGA – CPLD – 8085 and 8051 architectures – instruction sets – programming – interrupt structures – memory interfacing - interfacing of 8255 PPI, 8279 key board display controller, 8253 timer Counter – interfacing with 8085 – *A/D* and D/A converter interfacing.

UNIT 4: ELECTRICAL AND ELECTRONIC MEASUREMENTS

Ballistic, D'Arsonval galvanometers - principle, construction, operation and comparison of moving coil, moving iron meters, dynamometer, induction type and thermal type meter, rectifier type - theory, calibration – electrodynamometer type wattmeter – induction type kwh meter – induction type energy meter – dc potentiometer – ac potentiometer - C.T and P.T – Wheatstone bridge – Kelvin double bridge - high resistance measurement - earth resistance measurement - Megger.

Measurement of inductance, capacitance – Q of coil – Maxwell bridge - Wein's bridge - Schering bridge – Anderson bridge – Campbell bridge to measure mutual inductance – digital voltmeters and multimeters – microprocessor based DMM with auto ranging and self-diagnostic features – digital IC tester - frequency, period, time interval and pulse width measurement – cathode ray oscilloscope – sampling and storage scopes – wave analyzers – seven segment and dot matrix display - digital recording and data loggers - modern instrumentation and control systems – OSI model – EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard - 20 ma current loop - serial interface converters.

UNIT 5: CONTROL SYSTEMS

Open and closed loop systems - transfer function – signal flow graphs – time domain response-I and II order system response – frequency response – Bode plot – polar plot – determination of closed loop response from open loop response – correlation between frequency domain and time domain specifications – characteristic equation – location of roots in s plane for stability - Routh Hurwitz criterion – root locus construction – effect of pole, zero addition – gain margin and phase margin – Nyquist stability criterion - lag, lead and lag-lead networks – compensator design using bode plots – state space analysis – controllability and observability – pole placement - state observer design – features of linear and non-linear systems – phase plane analysis of linear and non-linear systems – isoclines method – describing function analysis of non-linear systems – conditions for stability - Liapunov's stability concept

- Liapunov's direct method - Popov's criterion – time varying optimal control - LQR steady state optimal control – optimal estimation-multivariable control design.

UNIT 6: TRANSDUCERS AND SMART SENSORS

Units and standards – calibration methods – static calibration – classification of errors - error analysis – statistical methods – odds and uncertainty – classification of transducers - selection of transducers – characteristics of transducers – mathematical model of transducers - zero, I and II order transducers – response to impulse, step, ramp and sinusoidal inputs – variable resistance transducers – variable inductance and variable capacitance transducers – induction potentiometer – variable reluctance transducers –principle of operation, construction details, characteristics and application of LVDT - capacitive transducer and types – capacitor microphone – frequency response –piezoelectric transducer, hall effect transducer – different types of photo detectors - digital transducers – smart sensors – fibre optic sensors, squid sensors,film sensors, MEMS - nano sensors.

UNIT 7: INDUSTRIAL AND ANALYTICAL INSTRUMENTATION

Pressure, flow, temperature and level measurements – principle of operation, installation and maintenance, calibration - measurement of force, torque, velocity, vibration, humidity, viscosity. and density – spectrophotometers (UV and IR) – pH meters – conductivity meters –analyzers (O_2 NO_2, H_2S), chromatography (gas and liquid) - NMR spectroscopy, x-ray spectroscopy and mass spectrometer.

UNIT 8: DIGITAL SIGNAL PROCESSING

Classification of signals: continuous and discrete, energy and power; mathematical representation of signals – classification of systems: continuous, discrete, linear, causal, stable, dynamic, recursive, time variance – spectral density – aliasing effect – digital signal representation - DTLTI systems – difference equations – convolution – IIR design: analog filter design – Butterworth and Chebyshev approximations – digital design using impulse invariant and bilinear transformation - Discrete Fourier Transform - IDFT- computation of DFT using FFT algorithm – DIT and DIF using radix 2 FFT - FIR and IIR filter realization – parallel and cascade forms - FIR design: windowing techniques – linear phase characteristics.

UNIT 9: PROCESS CONTROL

Mathematical model of first order level, pressure and thermal processes – higher order process - interacting and non-interacting systems – continuous and batch processes – servo and regulator operations – characteristics of on-off, proportional, integral and derivative control modes - PI, PD and PID control modes – pneumatic and electronic controllers – optimum controller evaluation criteria - IAE, ISE, ITAE and % decay ratio – determination of optimum settings for mathematically described processes using time response and frequency response - tuning – process reaction curve method – Ziegler Nichols method – damped oscillation method- feed – forward control – ratio control – cascade control – inferential control – split – range control –introduction to multivariable control – I/P converter - pneumatic and electric actuators - valve positioner – control valves - characteristics of control valves - inherent and installed characteristics - valve body – commercial valve bodies – control valve sizing – cavitation and flashing - selection criteria.

UNIT 10: LOGIC AND DISTRIBUTED CONTROL SYSTEM

Components of PLC – advantages over relay logic – architecture of PLC - programming devices – discrete and analog i / o modules – programming languages – ladder diagram - programming timers and counters – design of PLC – program control instructions, math instructions, sequencer instructions - use of PC as PLC – application of PLC – SCADA - data acquisition system – supervisory control – direct digital control – DCS – architectures – comparison - local control unit – process interfacing issues – communication facilities – operator interfaces - low level and high level operator interfaces – operator displays – engineering interfaces – low level and high level engineering interfaces.