

## Syllabus for (Instrumentation) -TECHNICAL ASST

|  |  |
|--|--|
|  |  |
|--|--|

|  |  |
|--|--|
|  |  |
|--|--|

### **ELECTRONIC DEVICES & CIRCUITS**

#### **Unit 1: Semiconductor and Diodes:**

**Semiconductor** – Definition, Classification, Intrinsic and Extrinsic N type & P type -Drift current & Diffusion current, Diodes-PN junction diode-Forward and Reverse bias characteristics-Specification-Zener diode-Construction & working 1 principle-Characteristics- Zener break down-Avalanche break down-Zener diode as a voltage regulator - Applications-Specifications

**Rectifier**-Introduction-Classification of Rectifiers-Half wave rectifier- Fullwaverectifier (Center tapped, Bridge) – (no mathematical equations) – comparison - Applications – Filters – C, LC, and PI Filters

#### **Unit 2 : Bipolar Junction Transistor:**

**Transistor** – NPN and PNP transistor – operation- Transistor as an amplifier – Transistor as a switch - Transistor biasing – Fixed bias, Collector base bias, Self bias – CB, CE, CC Configurations – Characteristics – Comparison between three configurations in terms of input impedance, 2 Output impedance, Current gain, Voltage gain – Classification of amplifiers -

RC coupled amplifier– Emitter follower and its application - Negative feedback – Basic concept, effect of negative feedback -Types of Negative feedback connections

#### **Unit 3 : Transistor Oscillators and FET and UJT:**

**Transistor oscillator** – Classifications – Condition for oscillations (Barkhausen criterion) General form of LC oscillator – Hartley Oscillator – Colpitts Oscillator – RC Phase shift oscillator- Crystal oscillator.

**Field Effect Transistor** – Construction – Working principle of FET – Difference

between FET and BJT – Classification of FET - Characteristics of FET – Applications – FET amplifier(Common source amplifier).

**Uni Junction Transistor** – Construction – Equivalent circuit – Operation – 5 Characteristics – UJT as a relaxation oscillator

**Unit 4 : SCR, DIAC, TRIAC & MOSFET:**

**SCR** – Introduction – Working – Comparison between SCR and Transistor – VI Characteristics – SCR as a switch , Controlled rectifier - TRIAC- working principle Characteristics - DIAC – characteristics – DIAC as bi-directional switch.

**MOSFET** – Types & characteristics of both N, P channel MOSFET. Characteristics of Enhancement and Depletion Mode MOSFETs.- MOSFET as a switch. Applications of SCR, TRIAC, DIAC and MOSFET

**Unit 5 : Opto Electronics Devices and wave shaping circuits:**

Classification of opto electronic devices – symbols, Characteristics, working of LDR , LED, 7 segment LED and LCD– optocoupler - Photo transistor. Clipper, Clamper Circuits and waveforms only – Solar Cell Principles – Applications ,Astable, Monostable and Multivibrators using Transistors -Schmitt Trigger using Transistors.

**ELECTRICAL CIRCUITS AND MACHINES**

**Unit 1 : DC Circuits and DC Network Theorems** Concept of electrical quantities – Voltage – current – resistance – power – energy – ohm’s law – Resistances in series – Resistances in parallel – series parallel circuits – Kirchhoff’s laws Super position, Thevenin’s, Norton’s and maximum power transfer theorems – Statement and explanations – Simple problems.

**Unit 2 : AC Circuits** AC fundamentals – AC waveform – sinusoidal and non-sinusoidal – period – frequency – cycle – amplitude – phase – peak value – average value – RMS value (effective value) – form factor – crest factor

AC Through pure resistor, inductor and Capacitor – Concept of impedance – vector diagram. Capacitors in series and parallel – energy stored in a capacitor– derivation – simple problems. Power in AC circuits – power factor– RL, RC and RLC series and parallel circuits – simple problems. Introduction of Harmonics - Effects of Harmonics

**Unit 3: Resonance and 3  $\Phi$  AC circuits**

Resonance – condition for resonance – series and parallel resonance – resonance curve – effect of resistance on resonance curve – selectivity – Q factor and bandwidth – applications of resonance – simple problems in resonance. Concept of 3 $\Phi$  supply – line and phase voltage and current in star and delta connected circuits – three phase power – Measurement of three phase power by two watt meter method – simple problems – advantages of three phase over single phase system.

## **Unit 4 : D.C Machines and A.C Machines**

DC machines – Types – constructional details of DC machines – DC generators – principle – types – emf equation – characteristics of shunt, series and compound generators DC motor – types – motor action – back emf – torque speed characteristics – starting of motors using 3 and 4 point starters – speed control of DC motor-applications. AC machines – 3 $\phi$  alternator – construction and working – relation between speed and frequency. 3 $\phi$  Induction motor – construction – types – principle of operation – methods of starting of 3 $\phi$  induction motor – slip. Single phase induction motor – principle of operation – capacitor start - motors – Applications – principle of operation -Stepper motor .

## **Unit 5 : Transformers**

Transformer – Ideal transformer – principle of working – constructional details – emf equation – turns ratio – core loss – copper loss – efficiency – regulation – SC and OC tests – simple problems. Transformer on No load – Transformer on load – condition for maximum efficiency – All-day efficiency(simple problems). Auto transformer – construction and working – applications.

## **BASICS OF INSTRUMENTATION**

### **FUNDAMENTALS OF INSTRUMENTATION**

Definition – Measurement, Instrument, Instrumentation system. Generalized Functional block diagram of an Instrumentation system – Examples – Bourdon tube pressure gauge, Pressure Thermometer. Definition – Standards, Primary, Secondary and Working Standards –Definition – Error, True value, Correction, Calibration, Zero error, Backlash error- Classification of errors – Gross error, Systematic error, Random error. Statistical analysis of test data – Arithmetic mean, Deviation, Standard Deviation, Variance, Simple problems.

### **PERFORMANCE CHARACTERISTICS OF INSTRUMENTS**

Static characteristics – Range, Span, Accuracy, Precision, Significant of figure, Range of doubt, Dead time, Dead zone, Hysteresis, Threshold, Resolution, Sensitivity, Linearity, Reproducibility, Stability, Loading effect, Input impedance and Output impedance. Dynamic characteristics – Speed of response, Measuring lag, Fidelity and Dynamic error. Standard Test input signals - Dynamic response – Steady state and Transient response.

### **TRANSDUCERS AND SENSORS**

Transducer – Definition, classification – Primary and Secondary transducer, Active and Passive transducer, Analog and Digital transducer, Transducer and Inverse Transducer (with one example for each classification). Characteristics of transducer – Input characteristics, Output characteristics and transducer Response. Factors to be considered in the selecting of Transducers. Electrical Transducer- Advantages of electrical Transducer over Mechanical Transducer. Sensors – Pressure Sensor, Proximity and Displacement sensor, Magnetic sensor, Bio sensor, Hall-effect sensor, Optical sensor.

## **MECHANICAL TRANSDUCER**

Definition- Mechanical pressure transducer - Elastic element – Bourdon tube, Bellows, Diaphragms. Manometers – U Tube manometer, Well type manometer, Barometer, Inclined tube manometer, Ring balance manometer, Micro manometer, manometric fluids- Construction, Principle, Working and Applications only –Thermal detectors – Liquid in glass thermometer, Filled system thermometer, Bi-metallic thermometer- Construction, Principle, Working and Applications only. Hydro-pneumatic elements – Venturi and Orifice - Construction, Principle, Working and Applications only.

## **ELECTRICAL TRANSDUCER**

Definition- Resistive Transducer-Potentiometer–types, PiezoResistive effect- Strain gauge – types – bonded, unbonded and semiconductor. Resistance Temperature Detector - Thermo-couple, Thermistor, Thermo-diodes and transistors – Construction, Principle, Working and Applications only. Variable Inductance

Transducer - LVDT, Variable capacitance transducer - Construction, Principle, Working and Applications only. Piezo-electric Transducer – Piezo electric effect, materials, Modes of  
oCourseName : DIPLOMA IN INSTRUMENTATION AND CONTROL ENGINEERING

## **ANALOG AND DIGITAL ELECTRONICS**

**Linear ICs: Op-amps, Timers and their applications** Operational amplifier – Ideal Op.Amp – Block diagram and characteristics –Op-amp parameters – CMRR – Slew rate – Virtual ground – Applications of op-amp – Inverting amplifier – Summing amplifier – Non inverting amplifier – Voltage follower – Comparator – Zero crossing detector – Integrator – Differentiator – Op- Amp Specifications. 555 Timer – Functional Block diagram – Astable, Monostable and Schmitt Trigger – Sequence timer,555 timer can be used as PWM.

**Boolean Algebra** Number systems – Decimal – Binary – Octal – Hexadecimal – BCD – Conversion from one number system to other – Boolean Algebra – Basic laws and Demorgan's Theorems – Logic gates – OR – AND – NOT – NOR – NAND – EX-OR Symbols, Truth table and Boolean expression – Realization of gates using universal gates NAND, and NOR – Problems using 2, 3, and 4 variables – Boolean expression for outputs – Simplification of Boolean expression using Karnaugh map (up to 4 variable)- Constructing logic circuits for the Boolean expressions.

**Combinational Logic** Arithmetic circuits – Binary addition – Binary Subtraction – 1's complement and 2's complement – Signed binary numbers – Half adder – Full adder – Half subtractor – Full subtractor – Parity Generator and checker – Digital comparator – Arithmetic Logic Unit – Decoder – 3 to 8 decoder – BCD to seven segment decoder – Encoder – Multiplexer – Demultiplexer – Digital Logic families – TTL – CMOS – LS series – Fan in – Fan out – Propagation delay – Noise immunity for the above families.

**Sequential Logic** Flip-flops – RS – D – T – JK – Master Slave Flip Flops – Edge triggered FF – Asynchronous Binary Counter – Decade counter – Mod n counter – Up Down Counter –

Preset table counter – Ring counter – Johnson counter – Synchronous counter – State diagram – Shift register – 4 bit shift register – Serial in Serial out – Serial in Parallel out – Parallel in serial out.

**D/A, A/D and Memory** D/A Converter – Basic concepts – Weighted Resistor D/A converter – R-2R Ladder D/A converter – Specification of DAC IC. Sampling and quantization – Analog to digital conversion using Ramp method – Successive approximation method – Dual slope method, simultaneous method voltage to frequency converter – Frequency to voltage converter specification of A/D converter. Memory – Static Memory – Dynamic Memory – Static Memory organization in terms of address lines, control lines and data lines — SDRAM – DDR RAM

## **MESUREMENTS AND INSTRUMENTS**

### **MEASURING INSTRUMENTS**

Basic forces for indicating instruments – constructional features of permanent magnet and moving coil instrument – moving iron instrument – attraction and repulsion types – rectifier type ac volt meter – ohm meter – series and shunt type – extension of range using shunt and multipliers – analog Multimeter circuits – dynamo meter type wattmeter - 1 $\phi$  & 3 $\phi$  induction type energy meter, Multifunctional Meters.

### **BRIDGES AND OSCILLOSCOPE**

Construction, working, balance equation (derivation not required) and application of measurement of resistance by Wheatstone bridge – measurement of capacitance by Schering bridge – measurement of inductance by Maxwell's bridge – measurement of frequency using Wien bridge - RLC meter. Block diagram of oscilloscope – construction and working of CRT – horizontal deflection and vertical deflection – time base generator – CRO probes – voltage – current – active – passive probes - applications of CRO.

### **TEST INSTRUMENTS**

Block diagram, working and applications of DC power supply – fixed and variable – Audio signal generator – Function generator – Megger – working and applications. Instrument transformer – CT and PT – block diagram, working of recorders – XY recorder – strip chart recorder.

### **DIGITAL INSTRUMENTS**

Digital vs Analog instruments – Digital volt meter-Integrated type, Ramp type and successive approximation – Digital Multimeter– auto ranging – auto zeroing – auto polarity – Digital Frequency Meter – Block diagram- circuit diagram – Digital tachometer – digital panel meter using LCD – Digital storage oscilloscope, mixed storage oscilloscope.

### **OP - AMP APPLICATIONS**

Circuit diagram and working of ramp, triangular, square wave generators using operational amplifier – Differential amplifier – Instrumentation amplifier – Charge amp with zero electric crystal – low pass and high pass filters using op. amps – PWM - PLL – Functional block diagram Capture range – Lock range - applications.

## **MEASUREMENT OF PROCESS VARIABLES**

### **MEASUREMENT OF TEMPERATURE**

Mechanical methods – pressure spring – liquid – gas – Vapour in glass – liquid in steel – thermometers, Bimetallic thermometer - Construction, working, range, advantages, disadvantages and applications of above. Electrical methods – Thermo couples – Cold junction compensation – Lead wire compensation – Thermoelectric laws – series and parallel combination – thermopile – Bolo meter – Measurement of output of thermocouples using potentiometer and millivoltmeter – RTD – 3 wire and 4 wire - Thermistors. Construction, working, range, advantages, disadvantages and applications of above. High temperature measurement – Non contact methods – Total Radiation Pyrometers – Selective radiation pyrometer - Photo electric pyrometers – Optical pyrometers – Temperature transmitters.

### **MEASUREMENT OF PRESSURE**

Types and units of pressure - mechanical methods – Manometers (all types) – Elastic elements – Bellows – Diaphragms – Bourdon Tube. Electrical methods – Pressure measurements using strain gauge, capacitive transducer, LVDT and Piezo-electric transducer. Construction, working, range, advantages, disadvantages and applications of above. Pressure calibration – Dead weight tester. Transmitters – Differential pressure transmitters. Data transmission theory and Telemetry system - General telemetry system - Radio frequency telemetry system - Brief theory about modulation and demodulation.

### **MEASUREMENT OF FLOW (MECHANICAL)**

Bernoulli's theorem – Continuity equation – Reynolds's number – Types of flow – Inferential flow meters – Differential pressure type meters – Orifice plates – Venturi tube – Flow Nozzle – Dall tube - Pitot tube ( No derivation) – Positive displacement type meters – Nutating type meter – Oscillation piston type – Construction, principle, working, advantages and disadvantages of above.

### **MEASUREMENT OF FLOW (ELECTRICAL)**

Electromagnetic flow meter – Ultrasonic flow meter – Doppler and Transit time method – Swirl meter – Vortex shedding meter - Cross correlation meter – Thermal mass flow meter – solid flow measurement using conveyor belt method – Turbine flow – Target flow meter – Hot wire anemometer - Construction, principle, working, advantages and disadvantages of the above.

### **MEASUREMENT OF LEVEL , HUMIDITY AND MOISTURE**

Level – Measurement of differential pressure to indicate level, Measuring by the movement of float. Electrical methods – change in conductance – change in capacitance - Radiation method – sight glass – solid level – bin type and diaphragm type – level in open and closed vessel. Moisture – Moisture in granular materials, solid penetrable material in paper and textiles. Humidity – Measurement of humidity – Absolute humidity – Relative humidity – Psychrometer – Hair Hygrometer. Density and specific gravity – Definition – Measurement using weighing tube type. Construction, principle, working, advantages and disadvantages of the above.

## **INDUSTRIAL INSTRUMENTATION**

### **COMPARATORS**

Introduction -Types - Mechanical Comparators - Dial Gauge - Reed type comparator - Optical comparators - Optical lever - Cooke Optical Comparator - Zeiss ultra optimeter - Electrical Comparator - Electronic comparator - Pneumatic Comparators - Solex Pneumatic Comparator - Principle of operation, construction, advantages and disadvantages of the above comparators.

### **MEASUREMENT OF VELOCITY & ACCELERATION**

Linear Velocity Measurement - Doppler effect method - Linear encoder - Angular velocity measurement – Tachometer - Eddy current or Drug cup rotor A.C tachogenerator - Angular encoder - Accelerometer-Seismic Accelerometer – Piezoelectric Accelerometer – Strain gauge Accelerometer - Principle of operation, construction, advantages and disadvantages of the above.

### **MEASUREMENT OF FORCE, TORQUE AND SHAFT POWER**

Force Measurement: Definition- Principle of operation and construction - Equal and Unequal arm balance – Pendulum scale – Elastic element spring – Proving Ring - Load cell - Hydraulic load cell – Pneumatic load cell – Strain gauge load cell.

Torque measurement: Definition - Principle of operation and construction of - Gravity balance method – Optical torsion meter – Electrical torsion meter – Strain gauge torsion meter.

Shaft Power Measurement: Definition- Principle of operation and construction of - Prony brake Dynamometer – Rope Brake Dynamometer – Fluid Friction (Hydraulic) Dynamometer – Eddy current Dynamometer – D.C Dynamometer.

### **MEASUREMENT OF pH & GAS ANALYSIS**

pH: Definition - Electrodes - Principle of operation and construction - Hydrogen electrode - Calomel electrode - Quinhydrone electrode - Antimony electrode - Glass electrode.

Gas Analyzer: Principle of operation and construction - Oxygen analyzer – Paramagnetic oxygen analyzer – CO analyzer – SO<sub>2</sub> analyzer.

## **CHROMATOGRAPHY AND SPECTRAL METHOD OF ANALYSIS**

Chromatography: Definition - Classification - Principle of operation and construction – Gas Chromatography – Liquid chromatography – Retention time - Dead time - Chromatogram - Significance and advantages of chromatography.

Detectors: Principle of operation and Construction of TCD, FID, FPD, ECD.

Spectral Analysis: EMR Spectrum - Beer's law - IR/UV spectro photometry - General description - range of IR/UV radiation - measurement of IR/UV radiation - Instrumentation - IR/UV radiation sources -monochromator

## **Process Control Instrumentation**

### **SIMPLE PROCESS CONTROL SYSTEMS AND TERMINOLOGY**

Process – Continuous and Batch process – process variables Functional block diagram of an automatic process control system – set point – measured value – error - simple liquid level control system – flow control system – temperature control system with transportation lag – self regulation – Introduction to Piping and Instrumentation diagram- symbols for equipments, piping, instrumentation and control, P&ID diagram for simple liquid level control system 14Hrs

### **CONTROL PRINCIPLES**

Controller – reverse and direct action, controller modes – discontinuous – ON-OFF Control with differential gap, without differential gap – continuous – proportional controller – proportional band (PB) – effect of PB on a controller output – offset – integral control – Derivative control - PI – PD-PID definition, salient features, applications and limitations of above controllers – selection of control action – electronic controllers – error detector – two position controller – P,I,D, PI, PD, PID controllers – pneumatic controllers for PID action – flapper nozzle mechanism, pneumatic relay

### **TUNING OF CONTROLLERS**

Concept of tuning – criteria for controller tuning – quarter Decay ratio, IAE, ISE, ITAE – methods of tuning – open loop response method – process reaction curve – closed loop response method – ultimate cycle method - damped oscillation method.

### **FINAL CONTROL ELEMENTS**

Signal converters – P to I converter, I to P converter – actuator – electrical, pneumatic, hydraulic–control valve – characteristics - quick opening, linear, equal percentage-pneumatic valve – solenoid valve –split range control valve – single seat and double seat plug – electric motor actuated control valve – control valve sizing – CV rating – selection of a control valve – effect of cavitation and flashing on control valve performance

### **COMPLEX CONTROL SYSTEMS**



Feed forward control system, Feed forward control of heat exchanger. comparison of feedback control system and feed forward control system. Ratio control – examples - Cascade control – cascade control of heat exchanger –cascade control of distillation column. Direct digital control(DDC) of single loop, Direct digital control with multiple control loops.

## **MICROCONTROLLER**

### **Unit 1 : ARCHITECTURE & INSTRUCTIONS SET OF 8051**

#### **ARCHITECTURE OF 8051**

Comparison of Microprocessor and Microcontroller - Block diagram of Microcontroller – Functions of each block - Pin details of 8051 – ALU – ROM – RAM – Memory Organization of 8051 - Special function registers –Program Counter – PSW register –Stack - I/O Ports – Timer – Interrupt –Serial Port – Oscillator and Clock - Clock Cycle – State - Machine Cycle – Instruction cycle – Reset – Power on Reset – Overview of 8051 family

#### **INSTRUCTION SET OF 8051**

Instruction set of 8051 – Classification of 8051 Instructions – Datatransfer Instructions – Arithmetic Instructions – Logical instructions –Branching instructions – Bit Manipulation Instructions

### **Unit 2 : PROGRAMMING EXAMPLES**

#### **ASSEMBLER AND ADDRESSING MODES**

Assembling and running an 8051 program –Structure of Assembly Language –Assembler directives - Different addressing modes of 8051

#### **PROGRAMMES**

Multibyte Addition – 8 Bit Multiplication and Division – Biggest Number / Smallest Number – Ascending order / Descending order BCD to ASCII Conversion – ASCII to Binary Conversion – Odd Parity Generator – Even Parity Generator -Time delay routines

### **UNIT 3 : I/O AND TIMER**

**I/O** : Bit addresses for I/O and RAM – I/O programming – I/O bit manipulation programming.

#### **TIMER**

Programming 8051 Timers – Timer 0 and Timer 1 registers – Different modes of Timer – Mode 0 Programming – Mode 1 Programming - Mode 2 Programming - Counter programming – Different modes of Counter – Mode 0 Programming – Mode 1 Programming -Mode 2 Programming (simple programs)

### **UNIT 4 : INTERRUPT AND SERIAL COMMUNICATION**

#### **SERIAL COMMUNICATION**

Basics of Serial programming – RS 232 Standards - 8051 connection to RS 232 – 8051 Serial Communication Programming – Programming 8051 to transmit data serially - Programming 8051 to Receive data serially.

### **INTERRUPT**

8051 Interrupts – Programming Timer Interrupts – Programming external hardware interrupts – Programming the serial communication interrupt –Interrupt priority in 8051 (simple programs).

### **UNIT 5 : INTERFACING TECHNIQUES**

#### **IC 8255**

IC 8255 – Block Diagram – Modes of 8255.

#### **INTERFACING TECHNIQUES**

Interfacing external memory to 8051– 8051 interfacing with the 8255 – ASM Programming – Relays – Sensor interfacing – ADC interfacing – DAC interfacing - Keyboard interfacing – Seven segment LED Display Interfacing - Stepper Motor interfacing – DC motor interfacing using PWM

#### **CONTROL ENGINEERING**

#### **BASICS OF CONTROL SYSTEMS, LAPLACE TRANSFORM AND TRANSFER FUNCTION**

System – Linear & Non Linear, Continuous & Discrete - Control system - open loop & closed loop –Examples – basics of Laplace transform – Inverse Laplace transform – Transfer function –order and type of a transfer function – pole/ zero plot - Transfer function of Translational Mechanical system (simple second order system with one mass) – Transfer function of Electrical systems using R,L,C

#### **BLOCK DIAGRAM AND SIGNAL FLOW GRAPH REPRESENTATION**

Block diagram: Introduction – advantages – rules for block diagram reduction – simple problems.

Signal flow graph: Rules for reduction – Mason’s gain formula – applications of Mason’s formula – simple problems – comparison of block diagram reduction and signal flow graph methods.

#### **TIME RESPONSE**

Standard test signals (step, ramp, sine and Parabolic) – order and Type of system - I order, II order system – derivation – step response of I order, II order system – time domain specifications (definition & formulas only) – steady state error, static error constants – problems.

#### **FREQUENCY RESPONSE**

Frequency response of linear system –Advantages – Frequency domain specifications (definitions only) – bode plot – gain margin – phase margin – problems – polar plot – problems.

## **STABILITY**

Definition –Location of the roots on the s-plane for stability absolute stability – relative stability– characteristic equation – Routh’s stability criterion technique – construction of root locus – problems.

## **INSTRUMENTATION SYSTEM DESIGN**

### **DESIGN OF TRANSDUCERS AND SIGNAL CONDITIONING CIRCUITS**

Design of Thermocouple Circuit with Cold Junction Compensation, Linearization, Amplification and Conversion of its output to 4 to 20 mA current – Design of RTD bridge circuit with lead wire compensation and conversion of its output to 4 to 20 mA current – Design of Flow measurement devices – Orifice Plate, Venturi meter- Design of Charge amplifier – Instrumentation amplifier

### **DESIGN OF TRANSMITTERS AND CONTROLLERS**

Design of two and four wire transmitters with 4-20 mA output – Smart Transmitters –Design of On-Off Controller – Design of Pneumatic and Electronic PID Controller – Design of annunciators –Low Level and High Level annunciators

### **CONTROL VALVE SELECTION**

Function in the system –Pressure drop requirements for good control – Capacity requirements –Valve Rangeability– Choosing the Flow Characteristic – Choosing the Body Design – Body materials – End Connections – Choice of Single Seat Versus Double Seat design – Selection of Actuators – Split ranging Control Valves – Control Valve Sizing Equations – Constant Pressure System –Variable Pressure system –Valve selection guidelines.

### **ENGINEERING DESIGN CRITERIA**

Pneumatics Versus Electronics – Control Center design– Specifications for various Measurement and Control Systems – Flow measurement, Pressure measurement, Level measurement, Temperature measurement, Control Valves, Control Panels – Pneumatic and Electronic Transmission systems –Process Connections – Location of taps, Sealing instruments from the Process – Mounting instruments – Selections of Units, Charts and Ranges – Instrument Identification– Construction material

### **SAFETY IN INSTRUMENTATION AND CONTROL SYSTEMS**

Area and Material Classification – International Electro technical Commission (IEC)– Classifying a Hazardous Location – Techniques used to reduce Explosion Hazards – Explosion proof Housings – Sealing – Pressurization Systems – Intrinsic Safety – Definition – Design of Intrinsically Safe Systems – Basic techniques in the design of intrinsically safe apparatus –

Mechanical and Electrical Isolation – Current and Voltage Limiting – Shunt Elements – System design using Commercially available Intrinsically safe and associated apparatus

## **PROGRAMMABLE LOGIC CONTROLLERS**

### **ARCHITECTURE AND OPERATION OF PLC**

Evolution of PLCs - Hard-wired control systems. PLC – definition, features, Advantages, Relays .PLC parts and architecture – CPU – I/O section – Programming device - Memory - input field devices – output field devices - input module wiring connections, output module wiring connections- Power Supply -PLC versus computer - Types of PLC – single ended – multitask – control management- unitary - modular- small – medium – large. Developing circuits from Boolean expression – Hardwired logic to programmed logic – programming word level logic instruction – processor memory organization program files – data files – program scan.

### **PROGRAMMING OF PLC**

PLC Programming languages -Standard languages- Ladder diagram (LD) - Function block diagram (FBD) Sequential function chart(SFC)- Statement List(STL) (each one example program)Symbols of a PLC Input and output contact graphical languages(IES)– program format – Typical Numbering mode – Equivalent ladder diagram of AND, OR, NOT, XOR, NAND AND NOR gate equivalent ladder diagram to demonstrates De Morgan's theorem, Ladder design switches- Develop elementary program design of a 4:1 Multiplexer using ladder logic programming wired level logic instructions input, output, flag, timer, counter, latch.

### **PLC TIMERS AND COUNTERS**

Definition and Classification of a timer. Characteristics of a PLC timer – functions in a timer – resetting –retentive functions and function block format- non-retentive – classification – Timer ONdelay- Timer-OFF delay- Simple problems using timer PLC counter – Operation of a PLC counter – Counter parameters – Format of counter instruction and counter data file - count up (CTU)- count down(CTD) simple problems using counter.

### **ADVANCED INSTRUCTION**

Introduction - comparison instructions- Addressing format for micro logic system - Different addressing types - Data movement instructions - Mathematical instructions- Program flow control instructions - PID instructions. Program development and execution using Allen bradly PLC. Simplified start up process of a coal feeding to a boiler plant - elevator for 3 floor building - Traffic light control -conveyor belt Selection of PLC - Safety considerations built in the PLC's.

### **I/O Module Communication and networking**

Introduction – classification of I/O Module Input – Output system – Direct I/O, parallel I/O – Sourcing and sinking of serial I/O system. PLC interfacing-Discrete Input module –DC - AC –

Discrete output module – Analog input module single ended and output module - RTD input modules- Thermocouple- High speed Encoder-Stepper motor- RS-232 interface module- Differential input module. Types of Communication Interface. Parallel – serial – Parallel – IEEE 488 BUS- Serial \_ balanced – unbalanced- communication mode- simplex – Half duplex – full duplex features of good interface. Serial interface RS 232c. DB-9 connection of Rs232C Network Topology, Bus Ring, Star, Tree.

## **INDUSTRIAL POWER ELECTRONICS**

### **POWER DEVICES AND TRIGGER CIRCUITS**

Thyristor family –Working principle ,VI characteristics, Applications of SCR – Definitions for holding current, latching current,  $dv/dt$  rating,  $di/dt$  rating– Symbol, principle of working ,VI characteristics ,applications of Insulated gate bipolar transistor (IGBT), MOSFET and GTO. Triggering of SCR - Gate triggering –Types – Concepts of DC triggering, AC triggering, Pulse gate triggering – Pulse transformer in trigger circuit – Electrical isolation by opto isolator - Resistance firing circuit and waveform – Resistance capacitor firing circuit and waveform, Synchronized UJT triggering (ramp triggering) and waveform – Ramp and pedestal trigger circuit for ac load.

### **CONVERTERS (QUALITATIVE TREATMENT ONLY)**

Converters – Definition – Single phase Half controlled bridge converter with resistive load and resistive inductive load- importance of flywheel diode – Single phase fully controlled bridge converter with resistive load – voltage and current waveforms – Single phase fully controlled bridge converter with RL load —voltage and current waveforms. Commutation- Natural commutation – Forced commutation – Types of forced commutation (mention the types only) 3 phase half controlled bridge converter with resistive load - current and voltage waveform -3 phase fully controlled bridge with resistive load – current and voltage waveforms. Dual converter – modes of Dual converter

### **CHOPPERS**

Introduction – applications -principle of chopper-control strategies (time ratio and current limit control)-types of choppertype A, B, C, D, and E - step up chopper –Jones chopper – Morgan chopper-chopper using MOSFET – PWM control circuit for driving MOSFET in chopper. DC Transmission- principle – advantages – drawbacks.

### **INVERTERS & APPLICATIONS**

Inverter Definition Requirement of an inverter –Single phase inverter with resistive load – Single phase inverter with RL load –Methods to obtain sine wave output from an inverter- output voltage control in inverters - McMurray inverter – advantages- Basic 3 phase bridge inverter with 120 conduction mode – circuit, trigger sequence, waveform – Through pass inverter – Parallel inverter using IGBT. UPS – Need for UPS –ON Line UPS -OFF Line UPS - Comparison of ON line and OFF line UPS

## **NUMERICALLY CONTROLLED SYSTEMS**

Basic concepts of numerical control- Block diagram of numerical control system– Advantages, disadvantages , applications of numerical control system – Driving devices – Hydraulic system , Stepper motor - Programming systems ( mention the names only ) – Data processing unit – Data reading – Part programming – steps - Post processor Introduction to CNC / DNC – Basic concepts of CNC , DNC and AC system - Types of AC system - -Block diagram of ACO , ACC – Comparison between NC & CNC – Typical CNC system – Block diagram - Advantages of CNC system .

## **TEST ENGINEERING**

### **INTRODUCTION TO TEST ENGINEERING**

Need and Importance of Test Engineering – Principles of Fundamental Testing Methods – Basic Principles of Memory Testing – PCB Track Short Testing Methods – Concepts of Trouble Shooting PCBs - Manual and Automated PCB Trouble Shooting Techniques.

### **AUTOMATED TESTING METHODS AND TECHNOLOGY**

Introduction to Automated Test Techniques – Fundamental of Digital Logic Families - Concepts of Back-Driving / Node Forcing Technique and its International Defense Standard - Concepts of Digital Guarding - Auto Compensation - Clock Termination – Functional Test Methods - Functional Testing of Digital, Analog and Mixed Integrated Circuit – Different types of Memory Module Functional Test.

### **V-I(SIGNATURE) TESTING METHODS AND TECHNOLOGY**

Fundamentals of Electrical Characteristics - Effects of Curve Trace, Characteristics of Passive and Active Components - Understanding Composite VI-Curve and its deviations – Component Identification of Ageing Effects with VI Curve Trace, Input and Output Characteristics of Digital Integrated Circuits - Good Versus

### **BOUNDARY SCAN TESTING METHODS AND TECHNOLOGY**

Introduction to Boundary Scan – Need of Boundary Scan Test Technique - Principle of Boundary Scan Test - Boundary Scan Architecture - Application of Boundary Scan Test- Boundary Scan Standards - Boundary Scan Description Language (BSDL) – Interconnect test – Serial Vector Format (SVF) Test - Basic of JTAG Port - Digital Integrated Circuit Test using Boundary Scan Techniques.

### **ATE TEST PROGRAM & SEMICONDUCTOR TESTING**

**ATE in PCB Test** – Test Fixtures - Basics of Automatic Test Program Generation - Standard Test Data Format STDF – Basic of Digital Simulator - Introduction to Semiconductor Test, Use of Load Boards.

## **INDUSTRIAL AUTOMATION AND DRIVES**

### **INDUSTRIAL DRIVES**

Electric drive - Definition - Parts - Types - Individual - Group - Multi motor. Stepper motor - Definition - Step angle - Slewing rate Types -Variable reluctance -Hybrid - Closed loop control of stepper motor - Drive system(any one) - logic sequencer - Optical encoder. Servo motor - Definition - Types - DC servo motor - Permanent magnet DC motors - Brushless motor - AC servo motor - Working of an AC servo motor in control system - Induction motors - Eddy current drive for speed control of induction motors.

### **PNEUMATIC AND HYDRAULIC SYSTEMS**

Hydraulic system - Elements of Hydraulic system - Hydraulic power supply and accumulator. Pneumatic system-Introduction - Elements of Pneumatic power supply - Filter - Regulator-lubricator(FRL) - Pressure control valves - Pressure relief valve - Pressure reducing valve - Directional control valve(DCV) - Poppet and spool valve - 3/2 DCV - 4/3 DCV - 5/2 DCV - Valve symbols - Pneumatic circuits - Control of a single acting cylinder and double acting cylinder - Comparison between hydraulics and Pneumatics.

### **PROGRAMMABLE LOGIC CONTROLLER(PLC)**

Definition –Conventional Hard wired logicRelays- Features of PLC- Advantages of PLC over relay logic - Block diagram of PLC - Programming basics of PLC - Ladder logic - Symbols used in ladder logic - Logic functions - Timers - Counters - PLC networking - Steps involved in the development of Ladder logic program - Program execution and run operation by PLC - Ladder logic diagram for liquid level operation. List of various PLCs and their manufactures.

### **DISTRIBUTED CONTROL SYSTEM (DCS)**

Evolution of distributed control system - Definition of DCS - Functional elements of DCS - Elements of local control unit -Operator interfaces-Engineering interfaces -Types of information displays - Architecture of anyone commercial DCS - Advantages of DCS - Selection of DCS - List of various DCS and their manufactures.

### **ROBOTICS**

Definition - Robot anatomy - Classification of robots -sensors - Contact and non-contact Touch, tactile, range and proximity sensor - End effectors -Types of end effectors - Robot programming languages - Robot drives - Applications of robots - One specific application of industrial robot - Material handling - Automated guided vehicle system.

## **BIO MEDICAL INSTRUMENTATION**

### **Unit 1 : BIO-ELECTRIC SIGNALS AND ELECTRODES**

Elementary ideas of cell structure, Bio – potential and their generation – resting and action potential – propagation of action potential.

**Electrodes** – Micro – Skin surface – needle electrodes.

**CLINICAL MEASUREMENT:** Measurement of Blood pressure (direct, indirect) – blood flow meter (Electro magnetic & ultrasonic blood flow meter) – blood pH measurement - Measurement of Respiration rate – measurement of lung volume – heart rate measurement – Measurement of body and skin temperature - Chromatography, Photometry, Flurometry.

#### **Unit 2: BIO - MEDICAL RECORDERS:**

Electro cardiograph (ECG) – Lead system – ECG electrodes – ECG amplifiers – ECG recording units – analysis of ECG curves. Nervous system – EEG recorder – 10-20 lead system – recording techniques – EEG wave types – Clinical use of EEG – brain tumour Electro – myograph (EMG) – EMG waves – measurement of conduction velocity – EMG recording techniques – Electro – retinograph (ERG) Audiometer – principle – types – Basics audiometer working

#### **Unit 3 : III THERAPEUTIC INSTRUMENTS:**

Cardiac pacemaker – classification – External pace makers – implantable pacemaker – pacing techniques – programmable pacemaker – Cardiac defibrillators – types – AC and DC defibrillators - Heart lung machine with Block diagram. Dialysis – Hemo dialysis – peritoneal dialysis. Endoscopes Endoscopic laser coagulator and applications – physiotherapy equipment – short wave diathermy – micro wave diathermy – ultrasonic therapy unit (block / circuit) – Ventilators – types – modern ventilator block diagram.

#### **Unit 4: BIOTELEMETRY AND PATIENT SAFETY:**

Introduction to biotelemetry – physiological – adaptable to biotelemetry – components of a biotelemetry system – application of telemetry – elements of biotelemetry; AM, FM transmitter and receiver – requirements for biotelemetry system – radio telemetry with sub carrier – single channel and multi channel telemetry – Telemedicine; introduction, working, applications. Patient safety: Physiological effects of electric current – Micro and macro shock – leakage current – shock hazards from electrical equipment. Methods of Accident Prevention – Grounding – Double Insulation – Protection by low voltage – Ground fault circuit interrupter – Isolation of patient connected parts – Isolated power distribution system. Safety aspects in electro surgical units – burns, high frequency current hazards, Explosion hazards.

#### **Unit 5 : MODERN IMAGING TECHNIQUES:**

LASER beam properties – block diagram – operation of CO<sub>2</sub> and NDYag LASER – applications of LASER in medicine. X ray apparatus – block diagram – operation – special techniques in X-ray imaging – 12

**Tomogram** – computerized Axial tomography – Ultrasonic imaging techniques – Echo cardiography – Angiography – CT scanner - Magnetic resonance imaging techniques.



## **ROBOTICS**

### **Basic Configuration of Robotics and its Working**

Introduction – definition – basic configuration of robotics and its working –robot components – manipulator, end effectors, drive system, controller, sensors –mechanical arm – degrees of freedom – links and joints – construction of links, types of joint – classification of robots – Cartesian, cylindrical, spherical, horizontal articulated (SCARA), vertical articulated – structural characteristics of robots –work envelope and work volume - robot work volumes and comparison – wrist rotations – mechanical transmission, pulleys, belts, gears, harmonic drive – conversion between linear and rotary motion and its devices.

### **Robot Controller, Servo Systems**

Robot controller – level of controller – open loop and closed loop controller –servo systems — robot path control – point to point – continuous path control – sensor based path control – controller programming – actuators – dc servo motors – stepper motors – hydraulic and pneumatic drives - feedback devices – potentiometers – optical encoders – dc tachometers.

### **Robot Motion Analysis and Vision System**

Robot motion analysis – robot kinematics – robot dynamics - end effectors –grippers and tools - gripper design – mechanical gripper – vacuum gripper –magnetic grippers – sensors – transducers – tactile sensors – proximity sensors and range sensors – force and moment sensors and its applications and problems photoelectric sensors – vision system – image processing and analysis – robotic applications – robot operation aids – teach pendent – MDI and computer control

### **Robot Programming**

Robot programming – lead through methods and textual robot languages – motion specification - motion interpolation - basic robot languages – generating of robot programming languages – On-Line & Off-Line programming - robot language structure – basic commands – artificial intelligence and robotics.

### **Robot Application in Manufacturing**

Robot application in manufacturing – material handling –assembly finishing –adopting robots to work station - requisite and non – requisite robot characteristics –stages in selecting robot for individual application – precaution for robot –future of robotics. Economics analysis for robotics – cost data required for the analysis – methods of economic analysis – pay back method – equivalent uniform annual cost method – return on investment method.

## **EMBEDDED SYSTEMS**

### **Unit 1 : ARM PROCESSOR ARCHITECTURE**

The RISC,CISC and ARM design - Philosophy, Embedded System Hardware - ARM Development tools

**ARM PROCESSOR FUNDAMENTALS:** Data Flow model, Registers, modes of operation- Current Program Status Register, Pipeline -Exceptions, Interrupts, and the Vector Table. ARM nomenclature and families - Big Endian and Little Endian - ARM development tools.

### **Unit 2 : ARM INSTRUCTIONS SETS AND INTERRUPTS**

ARM and Thumb Instruction Sets, Data Processing Instructions- Branch Instructions, Load-Store Instructions -Software Interrupt Instruction, Program Status Register -Instructions, Conditional Execution, Stack Instructions.

ARM PROCESSOR EXCEPTIONS AND MODES Vector table, Priorities, link Register offsets - Interrupts, and IRQ / FIQ exceptions interrupt-Stack design and implementation.

SIMPLE PROGRAM: Addition, Subtraction, Multiplication in assembly language

### **Unit 3 : CACHE MECHANISM AND MEMORY**

Introduction to cache memory- memory hierarchy and Cache memory - Cache architecture and cache policies

CONCEPT OF FLUSHING AND CLEANING CACHE :Flushing and Cleaning ARM cache core.

CONCEPT OF CACHE LOCKDOWN : Locking Code and Data in Cache - Cache and write buffer - Stack and stack pointer - Comparison of cache and stack

MEMORY PROTECTION AND MANAGEMENT UNIT: Introduction to Protection unit, Protected Regions - Demonstration of an MPU system - Components of MPU - Importance of MPU - Memory management unit block diagram - Main components of MMU - Definition of Virtual Memory - Virtual Memory - working principle - Memory size & speed - Importance of MMU

### **UNIT 4 : LPC 2148 ARM CPU**

INTRODUCTION Architectural overview – Memory mapping – block diagram

SYSTEM CONTROL BLOCK FUNCTIONS PLL – Power control – Reset – VPB divider – Wakeup Timer - Memory Acceleration module – Timer 0 and Timer 1 - PWM – RTC – On chip ADC – On chip DAC- Interrupts – Vector interrupt controller – General Purpose Input/Output(GPIO) – Universal Asynchronous Receiver/Transmitter - I2C Interface

### **Unit 5 : EMBEDDED OS AND RTOS**

Fundamentals components to Embedded OS - Simple Little Operating System: Initialization - Memory model, interrupts and exceptions handling - Scheduler, and context switch

INTRODUCTION TO RTOS Real-time systems concepts, foreground/background systems - Critical sections, resources, multitasking - Context switching, scheduling, re-entrancy - Task priorities, mutual exclusion

SYNCHRONIZATION AND IPC Introduction to Semaphores and types - Inter process communication: pipes and message box.

**Note: The above syllabus is indicative and the questions in the test may include similar other topics pertaining to the level and content of essential qualification.**