INSTRUMENTATION (EE 604)

Attempt *Three* questions from each half
2 marks reserved for neatness in each half

Full Marks-70   **Time 3 Hrs**

FIRST HALF

1. (a) What is a Transducer? How do you classify a transducer? Cite example of each class.

    (b) What is the working principle of a potentiometer type transducer? Give its constructional details.

    (c) Comment about the linearity of its output. How linearity can be improved?   **[4+4+3]**

2. (a) Discuss the working principle of a primary strain transducer. Derive the expression for Gauge factor. Write the typical values of gauge factor for various materials.

    (b) How torque can be measured by using strain gauge?

    (c) A vertical column type load cell is having 4cm x 4cm section and four active strain gauges of 120Ω and gauge factor 2.0 each bonded to its four faces along the loading direction. Give a suitable bridge configuration for this. If the modulus of elasticity of load cell material is 2×10^4kgf/cm^2 and the bridge supply voltage is 6V, determine the output voltage for an applied load of 5000kgf. What is the advantage of using such a bridge configuration?   **[4+2+5]**

3. (a) Draw push-pull variable reluctance type angular displacement transducer. What are the advantages of it over single element type?

    (b) What is an incremental level transducer? Mention one of its important applications.

    (c) Discuss how a capacitive transducer can be used to measure pressure on a thin diaphragm. If the diaphragm forming the moving plate of the capacitor is of 15cm diameter, kept initially taut by a radial tension of 2kg/cm and placed 2mm apart from the fixed electrode of 10cm diameter, find the change of capacitance value for unit change of air pressure on the diaphragm. Assume values of other variables if required.   **[4+3+4]**

4. (a) What is seismic measurement? Why measurement of absolute acceleration is preferred to that of displacement?

    (b) Draw the schematic diagram of a force balancing type accelerometer and explain its operation.

    (c) Why thermistors are the most preferred type of temperature transducer? A thermistor is showing a resistance of 900Ω at 40°C and 5kΩ at 2°C. Calculate the characteristics constants (α, β) for the thermistor at an ambient of 27°C and thus calculate its resistance at 100°C.   **[4+3+4]**

5. (a) How pressure can be measured by servo-manometer? Explain with a neat diagram.

    (b) Discuss the working principle of a non-contact type 4-bit Angular Digital Encoder.

    (c) Design an optical shaft encoder system to read a speed of 1000 rpm with a resolution of 0.1 rpm. Draw the schematic diagram of the system.   **[4+3+4]**

SECOND HALF

6   (a)   What is an Instrumentation Amplifier (IA)? What are the differences between IA and OA? Draw the internal circuit diagram of a 3-OA configured IA and obtain its I/O relation. Explain advantages and disadvantages of this configuration and suggest its modifications to overcome the disadvantages.

      (b)   Draw the circuit diagram of a 2-bit Programmable Gain Data Instrumentation Amplifier using suitable CMOS transmission gate based MUX/DMUX circuits and following 3-OA configuration. Show with the help of a table gains for different select data.   **[5+6]**

7   (a)   Explain construction and operation of Hall Effect devices used as electronic/ electrical signal isolators. Suggest some other isolating devices for the same purpose.

      (b)   Describe with circuit diagram the Isolation Amplifier using LED-Photo diode PCP (Photo Coupled Pair) for isolating Power System voltage signals.   **[5+6]**

8   (a)   Discuss use of pn diodes as precision full-wave rectifiers (Absolute Value Circuit), utilising only two pn silicon diodes and Adder (amplifier) circuit associated with two OA's.

      (b)   Describe active RMS value circuits for pure sinusoidal signal (i) using direct computation and (ii) by feedback computation and discuss their different demerits.
                                                                         [5+6]

9   (a)   What is Sampling Theorem? With the help of circuit diagram describe the operation of a Sampled and Hold (zero-order) circuit (S/H). Explain the utility of inter-connection between two voltage follower/buffer circuits here. Is it mandatory to connect an S/H circuit before an Analog to Digital Converter (ADC) circuit ? – Justify your answer.

      (b)   What is an ADC? Describe an ADC with its starting control and end of operation flag. Discuss the operation of a DAC using ADC.   **[5+6]**

10   (a)   Write short notes on *any one:*   **[5]**
          (i) Alpha-numeric Segmented and Dot-matrix displays;
          (ii) True-RMS value circuits and its advantages;
          (iii) Multi-channel DAS using Analog MUX and Digital MUX;

      (b)   Write technical notes on *any one:*   **[6]**
          (i) Gray-code to XS3-code converter circuit for 4-bit ten-position shaft encoder;
          (ii) Instrumentation Amplifier for current signal from a transducer;
          (iii) A single-bit programmable gain amplifier similar to a bi-polar
              Coefficient Multiplier for LVDT signal detection.