

B.E. INSTRUMENTATION & ELECTRONICS ENGG SECOND YEAR SECOND SEM 2019

Subject : **PROCESS INSTRUMENTATION - I** Time : 3 hours Full Marks : 100

Section 1 : Answer any one question

- 1a)** Discuss the working of a resonant wire or piezo-resistive pressure transmitter. Why is it called a 2-wire transmitter ? Show how such a transmitter is connected to a sinking type Receiver Instrument. **10**
- 1b)** A 2 wire transmitter having 4 – 20 mA output needs to be connected to a controller located in the control room 1200 ft away. If the loop power supply is 24 V DC, if transmitter needs a minimum voltage of 10 V for it to work properly, and if the input impedance of the controller is 600 ohms, then can a cable of resistance 34 ohm per 1000 ft be used for connection ? Give your comments. **5**
- 1c)** Why is current transmission preferred over voltage transmission ? Explain the concept of “live zero”. **5**
- 2a)** Draw a labelled sketch of a flapper-nozzle assembly. Explain its operation and discuss its input-output characteristics. Write down the expression relating the output pressure to the flapper – nozzle separation. Hence derive the expression for maximum sensitivity. **8**
- 2b)** A flapper-nozzle assembly has nozzle and orifice diameters 0.4 mm and 0.3 mm respectively. Calculate the displacement that the flapper has to undergo to produce a 3 to 15 psig signal. Assume supply pressure to be 20 psig. Is the constraint on maximum flapper displacement satisfied ? **4**
- 2c)** With the help of a functional diagram, derive the expression relating the force applied to the signal produced in a force balance type pneumatic transmitter. Comment on the span and zero adjustments. **8**

Section 2 : Answer any one question

3a) Explain the operation of a seismic accelerometer. Derive necessary expressions as required. Draw the frequency response curve for the same and discuss its significance. 12

3b) A body having speed between 2000 and 2400 rpm has one distinguishable mark. Discuss how its exact speed can be determined with a flashing light source if :- 8

(i) maximum available flashing frequency of the light source is 5000 flashes per min

(ii) maximum available flashing frequency of the light source is 2000 flashes per min

4a) With the help of a neat sketch, explain how an Absolute Encoder is used to measure angular displacement.

If the binary pattern obtained from an 8-track Absolute Encoder is 11001001 then find the limits within which the angular displacement lies. What is the resolution of such an encoder? 8 + 4 = 12

4b) Discuss the method of data transmission from an encoder to a smart card/ module using Synchronous Serial Interface in the Master – Slave mode where the encoder is the slave device. What is the significance of the Timeout time of the Encoder? 8

Section 3 : Answer any two questions

5) Describe the procedure of measuring pressure in the vacuum range with a McLeod Gauge. How is this instrument modified to obtain a linear scale? 15

6a) With the help of a neat, labelled diagram explain the principle of operation of a Bourdon Tube Pressure Gauge. How does variation in temperature cause errors in measurement? 8

6b) Draw a neat and labelled sketch to show how a Pressure Transmitter is installed for liquid service. In this context explain why a 2-valve manifold is used. 7

7a) Explain the working of a Cold Cathode Ionization Gauge. What is done to increase the probability of collision of the electrons with the gas molecules? 9

7b) A pressure transmitter has the following specifications :-

6

Range : 0 – 1 kg/cm²g to 0 – 20 kg/cm²g

max zero elevation : 200 % of calibrated span

max zero suppression : 100 % of calibrated span

What is the rangeability of this transmitter ? Specify the LRL and URL that is possible with this transmitter. What shall be the calibrated range if for a particular application this transmitter needs to have its zero suppressed by 50 % and if it must have a span of 10 kg/cm²g.

Section 4 : Answer both question 8 and 9

8a) Design a strain gauge load cell using four active elements with necessary signal conditioning circuits. Hence derive the expression for sensitivity of the same. What do you understand by the characteristic value of a load cell ? Discuss the advantage of a 6-wire load cell over a 4-wire type. 10

8b) Three 300 kg load cells having excitation voltage 12 V and characteristic value 4 mV/V are being used to weigh the contents of a tank. The tank is mounted on a three leg balanced structure and weighs 400 kg when empty and 700 kg when full. Each of the three supporting legs have one load cell each. Assuming the load to be perfectly distributed, find the output in mV from each load cell when the tank is $\frac{3}{4}$ full. 5

OR

8a) Draw the interconnection diagram of four load cells connected to a Weighing Controller via a Summing Junction Box. 4

8b) How is the flow rate of material controlled in a variable belt speed weigh feeder ? Discuss. 6

8c) In a weigh feeder, the motor speed can go upto 300 rpm to obtain a flow rate of 200 kg/sec. If the diameter of the belt pulley is 40 cm then determine the signal from 100 kg load cell (mounted between rollers 1m apart) with a 12V excitation voltage & having characteristic value 5 mV/V, when the motor speed is 180 rpm. 5

9) Write short notes on 5 + 5 + 5 = 15

a) I/P Converter or 2-wire V/I Converter

b) Incremental Encoders or Hall Effect Transducers

c) Cold Cathode Ionization Gauge or Chemical Seals