

Set-A

Roll No: -----



## UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech. ICE

Semester – V

Subject (Course): Transducers and applications

Max. Marks : 100

Course Code : ICEG 331

Duration : 3 Hrs

No. of page/s: 2

- Note: 1) Mention Roll No at the appropriate place in the question paper.  
2) Answers should be brief and concise.  
3) All questions are compulsory. Assume any missing data

### **Section A (20 marks) 5 marks each**

- Q 1. Enumerate the working of “**resistive transducers**”. Explain the auxiliary circuit required for signal processing of such transducers?
- Q 2. Elucidate the working of a “**capacitive transducer**” on the basis of variable area type. Identify practical application of such a transducer.
- Q 3. Elucidate the working of “**rotameter**”. Also state which physical variable can be measured with the help of rotameter?
- Q 4. Distinguish between a “**strain gauge**” and a “**load cell**”.

### **Section B (40 marks) 10 marks each**

- Q 5. A resistance wire “**strain gauge**” with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of  $100 \text{ MN/m}^2$ . The modulus of elasticity of steel is  $200 \text{ GN/m}^2$ . Calculate the percentage change in the value of the gauge resistance due to the applied stress. Comment on the results.
- Q 6. Design a “**water level**” indicator which displays the height of pure water stored in a tank.
- Q 7. Elucidate the working of a “**hot wire anemometer**” along with auxiliary circuit requirements.
- Q 8. An “**ultrasonic flow meter**” is utilized to measure the flow of liquid thorough the pipe. The trans-receivers are mounted axially along the flow axis. For this configuration deduce the expression to estimate the fluid velocity using the transit time principle

### **Section C (40 marks)**

- Q 9. Design a measurement device for the following applications: [10 marks each]
- a) A metallurgical plant utilizes natural gas fired furnace to generate the molten metal alloy which is rapidly cooled to form crystalline structure. Design a “**Non-contact type temperature**” measurement device to measure the temperature of molten metal alloy using emitted “IR” wavelengths.
- b) A steel rolling mill employs pneumatic drum press to achieve the desired depth of the steel sheet. Designs a measurement system which can be vertically installed along with

the tensiometers to monitor the “**thickness**” (depth) of the sheet. Clearly indicate the complete circuit diagram, and physical mounting of various elements required by device.

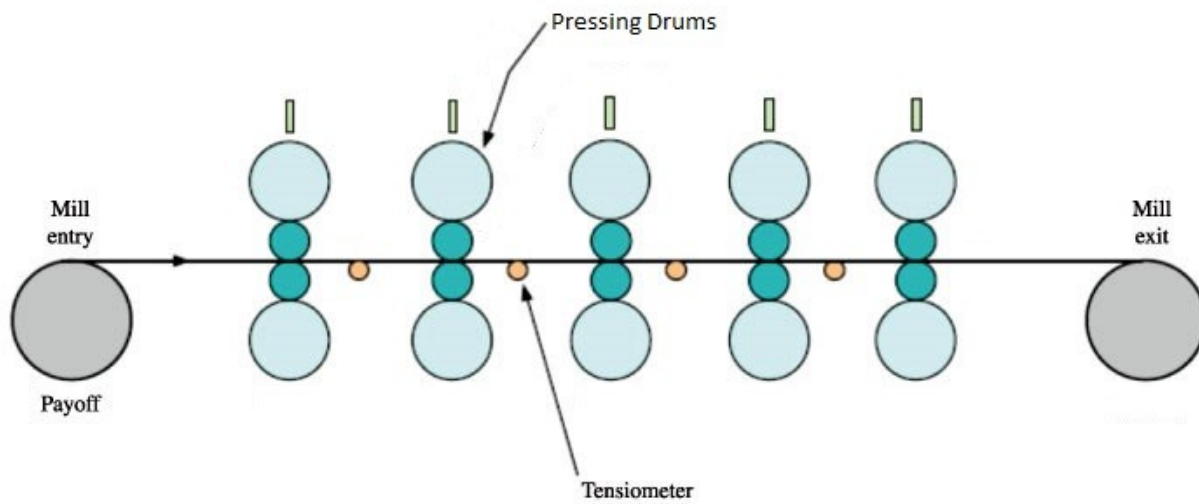


Figure 1 Steel mill pneumatic press

Q 10. A “**thermocouple**” is used to detect the temperature in a coffee vending machine. The output of thermocouple is  $2\text{mV}/^\circ\text{C}$ . Design a signal processing circuit which gives an output of  $5\text{V}$  for water temperature of  $100^\circ\text{C}$ . Assume thermocouple output to be  $10\text{mV}$  for  $25^\circ\text{C}$ . Also explain the calibration procedure of the measuring device. [20 marks]

Set-B

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**Section A (20 marks) 5 marks each**

- Q 1. Enumerate the working of “**inductive transducers**”. Explain the auxiliary circuit required for signal processing of such transducers?  
Q 2. Elucidate the working of a “**capacitive transducer**” on the basis of variable length type. Identify practical application of such a transducer.  
Q 3. Elucidate the working of “**hot wire anemometer**”. Also state which physical variable can be measured with the help of hot wire anemometer?  
Q 4. Elucidate the working of “**3-wire RTD**”. Draw its circuit connections.

**Section B (40 marks) 10 marks each**

- Q 5. Design a measurement system which measures the “**pressure**” inside a clean room for a semiconductor industry. The pressure range to be measured in  $10^{-8}$  to  $10^{-3}$  mm of Hg.  
Q 6. A “**transit time ultrasonic flow transducer**” uses two axially mounted piezoelectric crystals to measure flow a liquid through a pipe. It is used to measure the flow velocity for a fluid through a pipe. Calculate the flow velocity if:  
a) The distance between two crystals is 10 mm.  
b) The time elapsed in receiving the upstream pulse is 150 msec.  
c) The time elapsed in receiving the downstream pulse is 10 msec.  
d) Consider the velocity of sound in the medium as 300 m/s.  
Q 7. A “**platinum resistor**” {use:  $R_{20}=10\ \Omega$ ,  $\alpha=0.00393/^{\circ}\text{C}$ .} is used to monitor the temperature of coolant in a machine.  
a) Calculate the maximum resistance of platinum if the temperature does not exceed  $500^{\circ}\text{C}$ .  
b) Design a signal condition stage so as to generate an output voltage of 5V at  $450^{\circ}\text{C}$ .  
Q 8. A steel “**cantilever**” beam of dimensions: 0.25m long, 20mm wide, and 4mm thick is used to measure force applied by a pneumatic press.  
a) Calculate the value of deflection at the free end for the cantilever when a force of 25 N is applied at the free end of cantilever. The modulus of elasticity for steel is  $200\ \text{GN/m}^2$ .  
{Use  $x = \frac{Fl^3}{3EI}$ , where  $I = \frac{1}{12}bt^3$ }.

- b) The system uses an “LVDT” with a sensitivity of 0.5 V/mm. The LVDT output voltage is read on a 10V voltmeter having 100 divisions in which “two tenths” of a division can be read with certainty.
- c) Calculate the minimum and maximum value of force that can be measured with this arrangement.

### Section C (40 marks)

- Q 9. Design a measurement device for the following applications: [10 marks each]
- a) The liquid flow through a certain pipeline is measured using “venturimeter”. Design a “Capacitive DP cell” based system to convert the o/p signal from venturimeter into an electrical signal. Clearly indicate the complete circuit diagram, and physical interconnections of various elements required to design the measurement device.
  - b) For a home automation application the “temperature” of a room is monitored using thermistor and is controlled using a mobile application. Design an “IoT” based measurement device to upload the temperature readings on the cloud.
- Q 10. A natural gas plant produces 100 metric ton of gas in one batch. The gas produced is stored in 5 storage cylinders. For safety measures the average permissible pressure in a cylinder is 1 MPa. For this system design. [15+5=20 marks]
- a) A “load cell” based transducer system to measure the gas pressure inside the storage tank. Clearly indicate the complete circuit diagram, and physical mounting of various elements required by the load cell.
  - b) If the mean pressure range inside the storage tank is 0.1 MPa to 1.5 MPa. Explain the calibration procedure for such pressure measurement device if the output needs to transmit as a standard current signal.