

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING SECOND YEAR SECOND SEMESTER - 2023

Subject : INDUSTRIAL INSTRUMENTATION

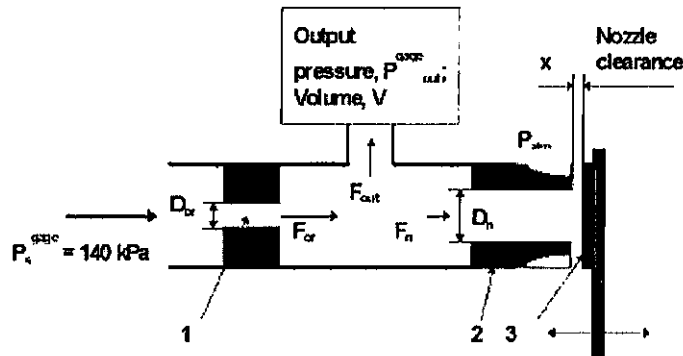
Time :3

Full Marks : 100

Write Question No. clearly. Don't write anything on the backside of the front page.

CO1 (ANY ONE)

- Q1
- i. Why a 0 mA Signal is Not Practical?
 - ii. How does a 2 wire transmitter work? 3+3+4+
 - iii. Design 2 wire transmitter using XTR116 5+5=20
 - iv. Compare 2 wire, 3 wire and 4 wire electronic transmitter.
 - v. The XTR116 has a minimum power-supply voltage, $V_{COMPLIANCE}$, of +7.5 V between $V+$ and I_0 for proper operation. If the resistive load due to cable length is R_{max} 900 ohm, what will be voltage compliance for max current transmission? Will the system be able to regulate the output current? If not, what are the probable solutions?
- Q2.
- i. How could you solve the nonlinearity of thermocouples for high-temperature measurement in different industrial applications.? Discuss with detail block diagrams 4+4+2+
5+5=20
 - ii. Explain the goal of system reliability of fault-tolerant computing
 - iii. What are the type of industrial maintenances?
 - iv. How can Functional Safety of E/E/PE system be achieved in two transmitter configuration? EXPLAIN WITH DIAGRAM
 - v. See the following flapper nozzle system;



The diameter of the supply restriction 1 is 0.2-0.3 mm (D_{or}), whereas that of the nozzle (D_n)2 is 0.8 mm. If the distance between the flapper 3 and the nozzle (3) is x , then, show the output gage pressure

$$P_{out}^{gag} = \frac{P_s^{gag}}{1 + 16 \frac{D_n^2 x^2}{D_{or}^4}}$$

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CO2 (ANY ONE)

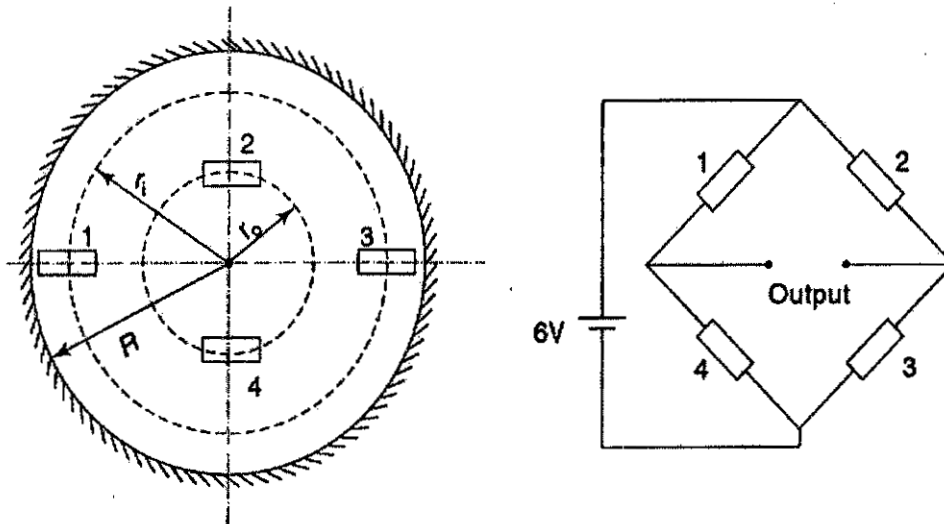
- Q4
- i. How does Eddy current type proximity sensor work? Explain with its elementary block diagram?
 - ii. Illustrate 3-wire DC PNP optical proximity sensor, explain it. 5+4+2+
 - iii. What do you understand by 'Vibration Pick up'? 4+5=20
 - iv. How a seismic instrument can be used to measure vibration?
 - v. An accelerometer has a suspended mass of 0.01 kg with a damped natural frequency of vibration of 150Hz. When mounted on an engine undergoing an acceleration of 1g at an operating speed of 6019 rpm, the acceleration is recorded as 9.5m/s^2 by the instrument. Find the damping factor and spring stiffness of the accelerometer.

- Q5
- i. Why is the limit switch important? Explain its operation.
 - ii. How Do Optical Commutation Encoders Work?
 - iii. Differentiate between Absolute Optical Encoder and incremental optical Encoder. 4+4+4+
 - iv. How can angular rotation of a shaft be measured using drag cup rotor tachogenerator? Why is it named with the words 'drag cup'? 4+4=20
 - v. A stroboscope is directed at a rotating disc having five equispaced radial lines on it. The highest flashing frequency at which a true pattern is observed is 2000 flashes/minutes. Give two other flashing frequency which would produce
 - 1. a 5-line pattern
 - 2. a 10-line pattern.

CO3 (ANY TWO)

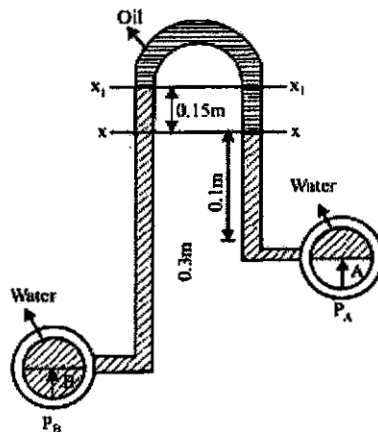
- Q6
- i. Explain the construction and working of the pressure switch?
 - ii. Elaborate the reasons behind error occurred in manometer? What are important factors to be taken care to choose a perfect manometer liquid? 5+5+5+
 - iii. Which adjustment need to be performed in bourbon tube for pressure measurement 5=20
 - iv. Explain the characteristic of Pressure regulator in details.
- Q7
- i. What are selection criteria of a pressure regulator? Elaborate your answer.
 - ii. How can you calibrate a pressure regulator for industrial uses? Explain in details. 4+4+4+
 - iii. Explain the working of spring loaded vacuum regulator with proper diagram. 8=20

- iv. The following figure shows a pressure transducer using a clamped diaphragm. Strain gauge 2 and 4 are meant to measure the tangential strain while gauges 1 and 3 measure the radial strain, find the open circuit sensitivity in mV/Pa, when Resistance of each gauge=120 ohm, Gauge factor =2, Radius $R=7\text{cm}$, $r_0=1\text{ cm}$ and $r_1=6\text{cm}$. Thickness t of the diaphragm =1mm, Young Modulus $E=2.07 \times 10^5\text{ N/mm}^2$, Poisson's ratio $\nu=0.25$



- Q8
- i. Explain the construction and working of Dead weight tester with diagram
 - ii. How does low pressure can be measured using Mcloed Gage? Derive the relation between vacuum pressure with pressure head difference in Mcloed Gage.
 - iii. An inverted differential U-tube manometer having an oil of specific gravity 0.8 as manometric liquid is connected to two different pipes carrying water under pressure. Determine the pressure in pipe B, if the pressure head in the pipe A is 2.0 m of water in figure below

6+6+8=20



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CO4 (ANY ONE)

- Q9
- i. What are the categories of the basic sensing elements used in Mechanical Dynamometers? Name the parameters based on which load cells or mechanical dynamometers are selected. 4+4+6+6=20
 - ii. What do you understand by *Inductive Coupling*?
 - iii. Explain construction and working of a mechanical dynamometer or load cell in cantilever beam configuration?
 - iv. How is the mechanical deflection of rotating torsion bars used as a means of measurement of small torque?

- Q10
- i. Explain your understanding about *Magnetostrictive Torque Transducer* with its construction and working principle. 4+4+4+4=20
 - ii. Where should the *Piezoelectric Dynamometers* be used? How do they work for load measurement?
 - iii. Explain your understanding about the *Pneumatic Relay Amplifier* operation with equivalent electrical circuit.
 - iv. How do *FIELD INSTRUMENT REDUNDANCY AND VOTING* technique are applied to basic process control systems (BPCSs) and *safety instrumented systems (SISs)*? Discuss in details.
 - v. An inclined micro manometer having a ratio of reservoir to limb areas as 10 was used to determine the pressure in a pipe containing water. Determine the pressure in the pipe for manometer reading, if the inclination of the manometer limb has a slope of 4:1 as shown in figure below

