Ref. No.: Ex/IEE/PC/B/T/223/2024

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING SECOND YEAR
SECOND SEMESTER EXAM 2024
SUBJECT : INDUSTRIAL INSTRUMENTATION
DURATION 3HR TOTAL MARKS 100

***Please ensure to explicitly state the question number, such as Q1.a), Q2.a), Q3.a), or Q4.a).***

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| Q1 | CO1 (any five).<br>***Explicitly state the question number such as Q1.a) or Q1.b) or..*** | 5x5 =25 |
| | a) Provide a comprehensive overview of 2 wire analog transmitters, highlighting their principles of operation, key components, and typical applications in industrial processes.<br>b) Compare and contrast analog transmitters with other types of sensor technologies used in process measurement and control.<br>c) Explain the operating principles of pneumatic transmitters in industrial instrumentation.<br>d) Explain the operating principles of NPN and PNP proximity sensors. Differentiate between the two types based on their construction, sensing mechanism, and output characteristics.<br>e) Explain the concept of instrument linearization in industrial measurement systems. Discuss why linearization is necessary and how it improves the accuracy of measurements.<br>f) Define *Reliability &Fault Tolerance*? What are the type of industrial maintenances? How do *Field Instrument Redundancy And Voting* technique are applied to *Basic Process Control Systems* (BPCSs) and *safety instrumented systems* (SISs)? Discuss in details.<br>g) Explain the fundamental principles underlying force and torque measurement systems. Discuss the types of sensors commonly used for measuring force and torque, their working principles, and the factors influencing their accuracy and precision.<br>h) Compare and contrast the operating principles of different types of load cells, including column, shear, and bending beam load cells, as well as magnetostrictive load cells. Discuss the advantages, limitations, and applications of each type of load cell in various industrial and research settings.<br>i) Explain the fundamental principles underlying torque measurement in rotating shafts. Discuss the concept of torque, its definition, units of measurement, and its significance in mechanical systems.<br>j) Why is a McLeod gauge considered to be a standard for measurement of pressure in the vacuum range? What are the limitations of a McLeod gauge? What modification is done to linearise the scale of McLeod gauge at higher pressures?<br>k) What is the theory of operation of Dead-weight-tester? What precautions should be observed while calibrating with Dead-weight tester? | |

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| | CO2 (any five)<br>***Explicitly state the question number such as Q2.a) or Q2.b) or….*** | |
| Q2 | a. Compare and contrast hot standby and cold standby redundancy systems in industrial applications. Explain the concept of fault tolerance and its importance in industrial redundant systems.<br>b. Describe the difference between hardware redundancy and software redundancy in industrial systems. Discuss the challenges associated with implementing redundant systems in industrial environments.<br>c. 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 1*g* 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.<br>d. Discuss the components and subsystems involved in a typical pneumatic transmitter system, including pressure regulators, pneumatic and relays . What is limit switch?<br>e. Design a belt conveyor weighing system for a specific industrial application, considering factors such as conveyor length, material flow rate, and accuracy requirements. Discuss the selection of suitable equipment and the integration of weighing technology into the conveyor system<br>f. Are Bourdon tubes also differential pressure gauges? Are they so used? Name such electrical pressure transducers which do not require the help of elastic elements like diaphragms, capsules, and bellows. What force will be developed against each square centimeter at the bottom of a tank 2 meters deep if the tank is filled with water?<br>g. Explain the measurement technique of angular rotation of a shaft using drag cup rotor ac tachogenerator ? Why it is named with the words ‘drag cup’?<br>h. 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<br>i. a 5 line pattern<br>ii. a 10 line pattern. | 5x5 =25 |
| | CO3 (any five)<br>E***xplicitly state the question number such as Q3.a) or Q3.b) or….*** | |
| Q3 | a) Explore the principles of working of the pressure switch and its construction too.<br>b) How can you calibrate a pressure regulator for industrial uses? Investigate the importance of calibration of a pressure regulator for industrial uses<br>c) Illustrate the complete block diagram of the compressed air system.<br>d) Analyze the performance characteristics of force and torque measurement systems, including linearity, sensitivity, resolution, and repeatability.<br>e) Define weigh feeders and explain their role in industrial material handling and process control. Discuss the advantages of using weigh feeders over volumetric feeding systems. | 5x5 =25 |

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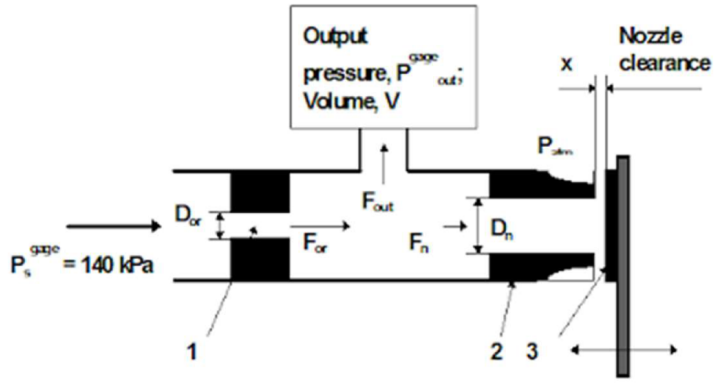
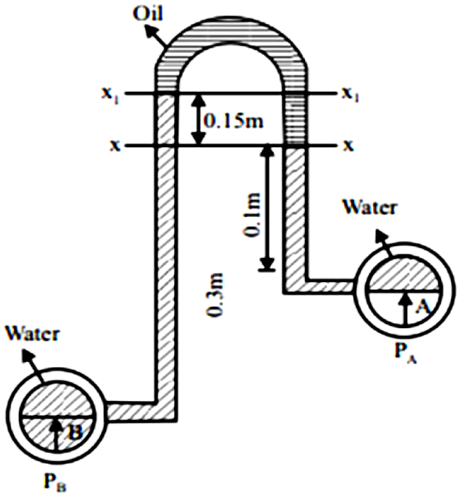
| | f) Suppose a weighted feeder is dispensing material inconsistently, leading to variations in product quality. How would you use data analysis and instrumentation knowledge to pinpoint the root cause of this inconsistency? explain the principle of volumetric feeding technique..<br>g) Explore dynamic balance devices such as Gyroscopic load cells, and force balance on industrial process instrumentation.<br>h) Elaborate the reasons behind error occurring in the manometer ? What are important factors to be taken care of to choose a perfect manometer liquid ?<br>i) See the following flapper nozzle system ;<br>  <br><br>The diameter of the supply restriction 1 is 0.2-0.3 mm (Dor), whereas that of the nozzle (Dn)2 is 0.8 mm .If the distance between the flapper 3 and the nozzle(3) is $x$ , then, show the output gage pressure<br>$$P_{out}^{gage} = \frac{P_s^{gage}}{1+16\frac{D_n^2 x^2}{D_{or}^4}}$$ | |
| | CO4 (any five)<br>***Explicitly state the question number such as Q4.a) or Q4.b) or….*** | |
| Q4 | a) Propose strategies for optimizing the performance of weigh feeders in industrial processes, such as material blending, batching, and dosing.<br>b) Identify common challenges encountered in the use of strain gauges and load cells, such as temperature effects, mechanical misalignment, and electrical noise.<br>c) Investigate the challenges associated with measuring torsion and torque in high-speed rotating machinery.<br>d) McLeod gauge has a volume of the bulb equal to 100 $cm^3$ and a capillary of diameter 1 mm. Calculate the pressure indicated by a reading of 3 cms. What error would result if the capillary volume is assumed to be negligible compared to the volume of the bulb.<br>e) Explain your understanding about the Pneumatic relay operation with an equivalent electrical circuit. | 5x5 =25 |

f) What are the fundamental principles underlying the measurement of position, displacement, velocity, and acceleration using sensors and transducers?
What do you understand by *Inductive Coupling* ?

g) 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




h) An inclined micromanometer 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