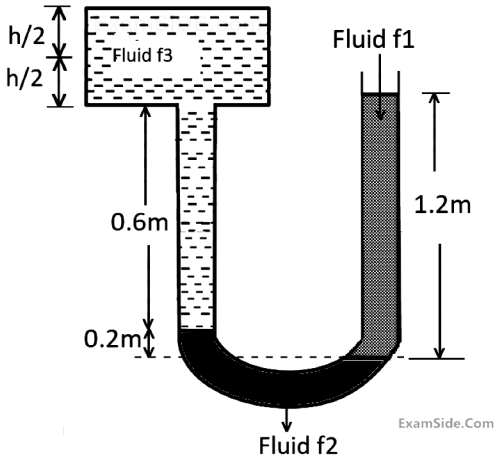
B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING
SECOND YEAR SECOND SEMESTER – 2025
Industrial Instrumentation

Time: Three hours **Full Marks: 100**

(ANY ONE) (CO2: Understanding based questions)		
Q1	1.i Why 0 psi Pneumatic Signal is Not Practical ? Examine the factors influencing the performance and reliability of pneumatic transmitters in industrial parameter measurement applications. 1.ii What is the theory of the Prony Brake system? 1.iii Evaluate the performance metrics and techniques used to assess the accuracy, reliability, and stability of electronics transmitters in industrial environments. 1.iv Examine the design considerations and challenges associated with integrating pneumatic transmitters into industrial process control systems. 1.v Explain the process of implementing linearization algorithms in microcontrollers or PLCs for real-time data processing in industrial applications. Discuss the computational requirements and considerations for efficient implementation	5*4 =20
Q2.	2.i How could you solve the nonlinearity of thermocouples for high-temperature measurement in different industrial applications.? Discuss with detail block diagrams 2.ii Explain the goal of system reliability of fault-tolerant computing 2.iii What is the type of industrial maintenance? What do you understand about Reliability-Centered Maintenance (RCM) and Total Productive Maintenance (TPM)? 2.iv iv). How can Functional Safety of Electrical/Electronic/Programmable Electronic (E/E/PE) systems be achieved in two transmitter configurations ? Explain with diagram 2.v Bourdon tubes also are differential pressure gauges. Are they so used? Why the bourdon tube isn't circular in cross section?	5*4 =20
(ANY ONE) (CO1: Knowledge based questions)		
Q3	3.i Explain how proximity probes (eddy current sensors) are used to measure shaft vibration. Describe the working principle, installation, and interpretation of signals. 3.ii Illustrate 3-wire DC PNP optical proximity sensor, explain it. 3.iii What do you understand by 'Vibration Pick up". Explain construction and working principle of an instrument which can be used to measure acceleration of a car. 3.iv A manometer is used for the pressure measurement in a closed tank. The three fluids f_1, f_2, and f_3 have specific weights γ, 2γ, and 0.5γ, respectively. The schematic arrangement with manometric readings and other dimensions are shown in the figure. In order to ensure zero gauge pressure in the tank at the mid-height level (h/2), what will be the height of the tank h. 	4*5= 20

Q4.	4.i	Explain your understanding about the pneumatic relay amplifier operation with equivalent electrical circuit.	4*5= 20
	4.ii	How do FIELD INSTRUMENT REDUNDANCY AND VOTING techniques are applied to basic process control systems (BPCSs) and *safety instrumented systems* (SISs) ? Discuss in details.	
	4.iii	Compare and contrast the operating principles of different types of load cells, including column, shear, and bending beam load cells, as well as the magnetostrictive load cells.	
	4.iv	Discuss the advantages, limitations, and applications of each type of load cell in various industrial and research settings.	
Any one (CO3:Analysis based questions)			
Q5	5.i	Analyze the operating principles of different types of weigh feeders, such as loss-in-weight feeders and gravimetric feeders. Discuss their suitability for handling various types of materials and applications.	4*5= 20
	5.ii	In a force-balance pressure transmitter, how does the interaction between mechanical elements (like the force bar and range bar) and pneumatic components (like the baffle-nozzle and bellows) help achieve and maintain balance? What would be the likely outcome if any one of these components failed or malfunctioned?	
	5.iii	Analyze the demand side of a compressed air system. What factors influence pressure loss, and how can poor design or maintenance lead to inefficiencies and increased operational costs?	
	5.iv	Compare rotary encoder and incremental encoder with construction , working and binary code output with respect to sector ranges .	
Q6	6.i	Differentiate between displacement, velocity, and acceleration in vibration analysis. Include diagrams or waveform comparisons for better clarity.	4*5= 20
	6.ii	Design a linearization algorithm to compensate for sensor non-linearity in a temperature measurement system using a thermocouple sensor.	
	6.iii	Why do we use polynomial equations to model nonlinear sensor responses? How does the order of a polynomial affect the accuracy of sensor modelling?	
	6.iv	Discuss the role of modularity and hierarchical computer architectures in large-scale industrial systems. How can future system designs integrate fault-tolerant features and simplified maintenance strategies to manage the increased complexity and ensure minimal downtime?	
ANY TWO (CO1& CO 4: Knowledge and Application based questions)			
Q7	7.i	Distinguish Cold Cathode and Hot Cathode Gauges for ultra high vacuum measurement?	4*5= 20
	7.ii	Discuss the role of the strobotron in a stroboscope. How does varying the frequency of the flashing light help in determining the rotational speed of an object? Illustrate your answer with a real-life example where this technique would be beneficial in industrial diagnostics.	
	7.iii	Differentiate between incremental and absolute optical encoders with respect to their construction, output signal, and mathematical principles of position determination. In which situations would one be preferred over the other?	
	7.iv	Propose engineering solutions to reduce pressure differentials and leakage within the distribution piping and end-use equipment. . How do components such as the compressor, air dryer, filters, and storage tanks work together to ensure clean and stable compressed air delivery?	

Q8	8.i A McLeod gauge has a capillary diameter of 1 mm and bulb volume 140 cc. Find the vacuum pressure when the reading is 10 mm. 8.ii The diameter of an aluminium sphere is found to be 50 mm at an atmospheric pressure of 10^5 Pa. The bulk modulus for aluminium is 68.6 GPa. Prove that the change in the diameter of the sphere in microns, when placed in vacuum is 0.024 8.iii Propose strategies for optimizing the performance of weigh feeders in industrial processes, such as material blending, batching, and dosing 8.iv 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 1200 flashes/minutes. Give two other flashing frequency which would produce a. 5 line pattern b. 10 line pattern.	4*5= 20
Q9	9.i Explain the characteristics of the Pressure regulator in details. 9.ii What are the selection criteria of a pressure regulator ? 9.iii How can you calibrate a pressure regulator for industrial uses? 9.iv Explain the working of spring loaded vacuum regulator	4*5= 20