 EX/ME/T/321/2018

B.E. Mechanical Engineering Third Year 2nd Semester Examination – 2018

Subject: **Mechanical Measurement and Instrumentation**

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

Different parts of the same question should be answered together.
Use of Gaussian Error Function Tables permitted.

CO1 [10]	[1] Give a schematic of a spring-loaded pressure gauge and explain its function. Also draw a block diagram to indicate the different functional elements of the system. [10]
CO2 [20]	[2] Differentiate between active-passive transducers, analog-digital modes, null-deflection methods of measurement. With a neat sketch explain the working principle of an active transducer. [12+8]
CO3 [20]	*Answer any* **two(2)** from **(a), (b) and (c)** *in this block:* [10+10] [3] (a) The discharge coefficient C_q of an orifice can be found by collecting the water that flows through during a time interval when it is under a constant head h as per the relation $C_q = W/\{t\rho A\sqrt{2gh}\}$. Find C_q and its possible uncertainty if: W=390±0.25kg; $A=\pi d^2/4$; d=12±0.03mm; t=600±2s; g=9.81±0.00981m/s^2; ρ=1050±1.05kg/m^3; h=3.6±0.03m. (b) With a block diagram, explain the generalized input-output configuration of a measurement system. Give an example to illustrate the different inputs. (c) Explain with examples **two** different methods for correction for interfering and modifying inputs.
CO4 [10]	*Answer any* **one(1) from (a) and (b)** *in this block:* [4] (a)Describe with a sketch and explain operation of the *unbonded metal wire gauge*. What is meant by gage factor of a strain gauge? [6+4] (b) Describe the principle of operation of an LVDT. [10]
CO5 [40]	*Answer any* **two(2) from (a), (b) and (c)** *from this block:* [5] (a) (i)What is meant by static calibration and what are the different steps for performing a calibration? (ii)Name the different types of biases possible in a measurement system. (iii) The thickness of a set of gaskets varies due to random manufacturing disturbances, but thickness values measured belong to a Gaussian distribution. If the mean thickness is 3mm and standard deviation is 0.25, calculate the percentage of gaskets that have a thickness greater than 2.5 mm. [7+5+8] (b)(i) The following average velocity (V)-hydraulic gradient (i) data of a Reynolds apparatus are expected to follow a linear relation of the form $V = mi + b$. Obtain the best linear relation in accordance with a *least-square analysis*. Calculate the *standard deviations* of *slope* and *intercept* from the predicted straight line relation.

V(m/s)	i	
	Increasing	**Decreasing**
0.015	0.0011	0.0012
0.030	0.0026	0.0028
0.047	0.0043	0.0046
0.069	0.007	0.0072
0.095	0.011	0.013
0.118	0.013	5:45
0.191	0.018	0.020

(ii) A measuring instrument with a time constant of 0.4 s and a static sensitivity of 0.01mV/^{0}C is used to measure the temperature of a medium, which changes from 15^{0}C to 80^{0}C. Taking the output as zero at 15^{0}C, find the time taken for the output to reach 70% of the steady state value, if the temperature change occurs suddenly. [12+8]

(c) (i)The thickness of a set of gaskets varies due to random manufacturing disturbances, but thickness values measured belong to a Gaussian distribution. If the mean thickness is 3mm and standard deviation is 0.25, calculate the percentage of gaskets that have a thickness greater than 2.5 mm.
(ii) For an underdamped second order system explain with a sketch the meaning of the terms – rise time, peak time, 2% settling time, maximum percentage overshoot. [10+10]