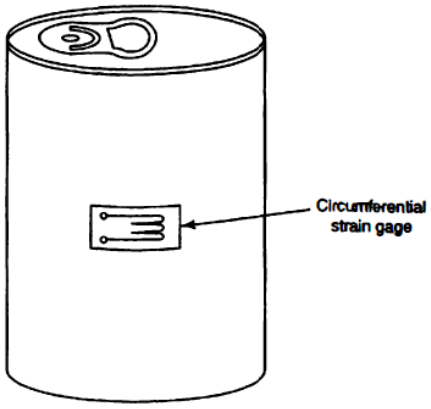
Model Question Paper

Total Duration (H:M):3:00

Course: Mechanical Measurement and Control (BMET-503)

Maximum Marks: 100

Q.No	Questions	Marks	CO	BL
1a	Differentiate between the following a. Accuracy and resolution b. Systematic and random errors	**5**	**CO1**	**L1**
1b	A quartz piezoelectric crystal having a thickness of 2 mm and a voltage sensitivity of 0.055 V · m/N is subjected to a pressure of 200 psi. Calculate the voltage output.	**5**	**CO2**	**L5**
1c	A commercial force sensor uses a piezoelectric quartz crystal as the sensing element. The quartz element is about 0.2 in. thick and has a cross section of about 0.3 in. by 0.3 in. The sensing element is compressed in the thickness direction when a load is applied over its cross section. The output voltage is measured across the thickness. What is the output of the sensor in volts per newton?	**5**	**CO3**	**L5**
1d	A hole and shaft have a basic size of 25 mm, and are to have a clearance fit with a maximum clearance of 0.02 mm and a minimum clearance of 0.01 mm. The hole tolerance is to be 1.5 times the shaft tolerance. Determine: limit for both hole and shaft (a) using a hole basis system (b) using a shaft basis system.	**5**	**CO4**	**L5**
2a	A mechanical engineering student wishes to determine the internal pressure existing in a diet soda can. She proceeds by carefully mounting a single-element strain gage aligned in circumferential direction on the centre of the soda can, as shown in the figure below. After wiring the gage properly to a commercial strain indicator, she "pops" the flip-top lid, which relieves the internal pressure. She notes that the strain indicator reads -400 μ strain. If the can body is made of aluminium with a thickness of 0.010 in. and a diameter of 2.25 in., what was the original internal pressure of the sealed can?  	**10**	**CO3**	**L5**
3a	Consider a mercury-in-glass thermometer as a temperature-measuring system. Discuss the various stages of this measuring system in detail.	**5**	**CO1**	**L1**
3b	A force cell uses a resistance element as the sensing element It is connected in a simple current-sensitive circuit in which the series resistance Rm is 100 ohms, which is one-half the nominal resistance of the force cell. Determine the current for force inputs of (a) 25%, (b) 50%, and (c) 75% of full range if the input voltage is 10 V.	**5**	**CO3**	**L5**
3c	The linearized model of the pendulum in the upright position is characterized by the matrices	**5**	**CO5**	**L5**

	$A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix}, \quad D = 0.$ Determine the transfer function of the system.			
3d	Show how strain gages may be mounted on a simple beam to sense temperature change while being insensitive to variations in beam loading.	**5**	**CO3**	**L1**
4a	Set up test procedures you would use to estimate, with the aid only of your present judgment and experience, the magnitudes of the common quantities listed. (a) Distance between the centrelines or two holes in a machined part (b) Weight of two small objects of different densities (c) Time intervals (d) Temperature of water (e) Frequency of pure tones	**10**	**CO1**	**L5**
5a	Water at 15°C and 650kPaflows through a 15 x 10 cm (15-cm pipe and 10-cm throat diameter) as-cast venturi tube. A differential pressure of 25kPa is measured. Calculate the flow rate (a) in kg/min and (b) in m^3/h.	**5**	**CO3**	**L4**
5b	Determine the factor for converting volume flow rate in cm^3/s units to gal/min.	**5**	**CO1**	**L2**
5c	What is LVDT? How it is useful in the measurement of displacement and pressure.	**5**	**CO2**	**L2**
5d	Differentiate between the transducers and sensors.	**5**	**CO1**	**L2**
6a	Differentiate between servo pressure transducer and ring balance gauge.	**5**	**CO2**	**L1**
6b	A 500-Hz sine wave is sampled at a frequency of 4096 Hz. A total of 2048 points are taken. (a) What is the Nyquist frequency? (b) What is the frequency resolution? (c) The student making the measurement suspects that the sampled waveform contains several harmonics of 500 Hz. Which of these can be accurately measured? What happens to the others?	**10**	**CO2**	**L4**
6c	The two resistors R and Rs are connected in series. The voltage drops across each resistor are measured as $E = 10\,\text{V} \pm 0.1\,\text{V}\ (1\%)$ $E_s = 1.2\,\text{V} \pm 0.005\,\text{V}\ (0.467\%)$ along with a value of $R_s = 0.0066\,\Omega \pm 1/4\%$ From these measurements determine the power dissipated in resistor R and its uncertainty.	**5**	**CO1**	**L5**