Exam Date & Time: 30-Apr-2022 (02:00 PM - 05:00 PM)



MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH END SEMESTER MAKE - UP EXAMINATIONS, APRIL 2022 SENSORS AND TRANSDUCERS [ICE 2155]

Marks: 50

Duration: 180 mins.

A

Answer all the questions.

Ins	tructions to	Candidates: Answer ALL questions Missing data may be suitably assumed	
1)		Explain the single turn rotational displacement resistive transducer. What are the factors on which the accuracy and precision of this device depend.	(4)
	A)		
	B)	Draw a neat diagram and explain the construction and working of a generalized measurement system.	(3)
	C)	With neat diagrams, explain the construction and working of LVDT. Illustrate the use of this sensor with an application.	(3)
2)		A parallel plate capacitor transducer with air dielectric having an area of 400mm ² is separated by a distance 0.3mm. Calculate the value of capacitance if a linear displacement reduces the distance between the plates to 0.21 ($\epsilon_{o=}7.5 \times 10^{-12}$ F/m).	(3)
	A)		
	B)	Explain the principle of operation of a rotating concentric cylinder viscometer	(3)
	C)	With neat diagrams and relavent mathematical expressions arrive at a scheme for use of capacitive transducer for angular displacement measurement.	(4)
3)		Strain gauges are used for making cantilever type load cells as shown in the following	

Strain gauges are used for making cantilever type load cells as shown in the following figure. Demonstrate a configuration in which the strain gauges should be placed on the cantilever for maximum sensitivity: elucidate the number of strain gauges to be used for
A) each measurement, the placement/ arrangement of the sensors and the electrical connections for measurement of resistance change.



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(4)

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B)	Select suitable sensors for the following applications:	(3)
	Non-contact measurement of distance, velocity and acceleration	
	Measure speed of a wheeled mobile robot developed mainly for indoor applications	
	Measure the force applied by a robotic hand to pick an object	
	Measurement of high frequency vibrations.	
C)	Design an electrochemical sensor for measurement of glucose in a blood droplet.	(3)
4)	A ruled grating of 600 lines/mm is illuminated normally with a sodium vapour lamp (589 nm and 589.59 nm). At what angle will the first order maxima occur.	(2)
A)		
B)	Design a piezoelectric quartz crystal with a resonant frequency of 6 MHz. When used as a QCM sensor, for a certain observation a frequency of 5.91 MHz is noted. Calculate the change in mass on the oscillating surface perpendicular to it. Some relevant information is provided as follows, others may be suitably assumed. Assume the area of cross section to be 1 cm2	(4)
	d31 = 2.3*10-12 C/N, d32 = -0.67*10-12 C/N, E = 4.5, E0=8.85*10-12 F/N, resistivity = 8*10^11 $\Omega m, \rho$ = 2.65 x10^3 kg/m3, Y = 80*10^9 Nm-2 , Max Safe Stress = 98*10^6 Nm-2.	
C)	Analyze the impedimetric response of a capacitive sensor when used in conjunction with an electrochemical impedance spectroscopy sensor system in the range from 100 Hz to 10 kHz.	(4)
	(Hint: If you know what a capacitor is and what EIS is, you should get this easily)	
5)	Design an optical sensor for measurement of refractive index from 1.33 to 1.66.	(4)
A)		
B)	Elucidate the functioning of a 8-bit rotary optical encoder with mathematical expressions. What is the sensitivity of this sensor.	(2)
C)	Describe the minimum essential building blocks of an optical sensing system with mathematical expressions and analytical reasoning as necessary.	(4)

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