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**PRESIDENCY  
UNIVERSITY  
BENGALURU**

**School of Engineering**

**Mid - Term Examinations - Nov 2024**

**Semester:** Seven

**Date:** 05/11/2024

**Course Code:** ECE3045

**Time:** 02:00pm – 03:30pm

**Course Name:** Sensor Technologies

**Max Marks:** 50

**Program:** B.Tech.

**Weightage:** 25%

**Instructions:**

- (i) Read all questions carefully and answer accordingly.
- (ii) Do not write anything on the question paper other than roll number.

**Part A**

**Answer ALL the Questions. Each question carries 2marks.**

**2Mx5Q=10M**

- |          |   |                |           |            |
|----------|---|----------------|-----------|------------|
| <b>1</b> | Identify the four essential components of a system that is used to measure the input stimulus and produce the output          | <b>2 Marks</b> | <b>L1</b> | <b>CO1</b> |
| <b>2</b> | List the differences between absolute sensor and relative sensor with an example for each                                     | <b>2 Marks</b> | <b>L1</b> | <b>CO1</b> |
| <b>3</b> | With a neat figure, describe threshold, offset and saturation.  | <b>2 Marks</b> | <b>L1</b> | <b>CO1</b> |
| <b>4</b> | Label the material parameter(s) and geometric parameter(s) that can be varied in a potentiometric sensor and inductive sensor | <b>2 Marks</b> | <b>L1</b> | <b>CO2</b> |
| <b>5</b> | Define Photoelectric effect in terms of photons, electrons and frequency  | <b>2 Marks</b> | <b>L1</b> | <b>CO2</b> |

**Part B**

**Answer ALL Questions. Each question carries 10 marks.**

**4QX10M=40M**

- |            |   |                |           |            |
|------------|---|----------------|-----------|------------|
| <b>6a.</b> | Dr. Tata developed and tested a flow sensor. He found that the transfer function of the sensor was $V = 0.25Q + 0.5$ , where V is the output voltage and Q is the flow rate in m/s. From the transfer function, infer the sensitivity of the sensor.  | <b>2 Marks</b> | <b>L2</b> | <b>CO1</b> |
| <b>6b.</b> | On performing some measurements on a displacement sensor, the output voltage of 1.125V was observed when the displacement was 1mm and 2V was observed at 8mm. Review this sensor and determine the transfer function of the sensor. Also, interpret if the sensor has any offset and saturation if the full-scale input is 9dB when the cut-off is 1mm. | <b>8 Marks</b> | <b>L3</b> | <b>CO1</b> |

**Or**

7	<p><b>7a.</b> Dr. Kalam designed, developed and tested a gas sensor. He found that the sensor had a transfer function was <math>V = 1.2C + 2</math>, where V is the output voltage and C is the concentration of gas in ppm. From the transfer function, infer what would be the sensitivity of the sensor.</p>	<b>2 Marks</b>	<b>L2</b>	<b>C01</b>
	<p><b>7b.</b> During test phase of an optical sensor, the transfer function of the sensor was found to have a non-linear quadratic behavior given by <math>I=0.5L^2+3L</math> where I is the output current and L is the illumination in lux. Interpret the non-linearity error at an illumination of 50lux.</p>	<b>8 Marks</b>	<b>L3</b>	<b>C01</b>
8	<p><b>8a.</b> Few students approached a semiconductor industry to study their success-to-failure ratio. They found that a significant number of devices failed during the usable phase after deploying to the market and before expiration. Interpret the reasons for these failures.</p>	<b>2 Marks</b>	<b>L2</b>	<b>C01</b>
	<p><b>8b.</b> A sales person is supplying thermometers for a much cheaper price for student's projects. The sensitivity of the thermometer is <math>2mV/^{\circ}C</math>, and the sensor has a relative error of 5% from the true value. If the output of the sensor is 300mV, then determine the actual temperature.</p>	<b>8 Marks</b>	<b>L3</b>	<b>C01</b>
<b>Or</b>				
	<p><b>9a.</b> While developing a sensor, the engineer should keep in mind the environment in which the sensor can be used. Review some of these factors that might affect the sensor.</p>	<b>2 Marks</b>	<b>L2</b>	<b>C01</b>
9	<p><b>9b.</b> An employee of Zebronics was asked to check the reliability of their keyboards by taking a sample of 100 keyboards. They found 30 of them failed during the initial phase with a mean time of 680 hours, 10 during the usage phase with a mean time of 1670 hours and remaining 60 survived the entire time of 2500 hours. Identify the reliability of the hard disks (in percentage) that does not fail until 2500 hours.</p>	<b>8 Marks</b>	<b>L3</b>	<b>C01</b>
	<p><b>10a.</b> A group of students are planning to build a sensor that will measure the distance that a ball has moved. Consult the students on a suitable sensor that would solve their problem and defend your consultation.</p>	<b>2 Marks</b>	<b>L2</b>	<b>C02</b>
10	<p><b>10b.</b> To measure the deflection of propeller's blades, ISRO developed a capacitance-based differential-mode sensor. The distance between the electrodes is <math>500\mu m</math> with an input voltage of 12V. When there is no deflection, the capacitance was 10pF. The maximum deflection that can be detected by the sensor is <math>100\mu m</math>. Predict the voltage that is to be provided by the sensor to the signal processor to indicate the presence of deflection.</p>	<b>8 Marks</b>	<b>L3</b>	<b>C02</b>
<b>Or</b>				
	<p><b>11a.</b> A group of students are planning to build a sensor that will measure whether a balloon is approaching the sensor. Consult the students on a suitable sensor that would solve their problem and defend your consultation.</p>	<b>2 Marks</b>	<b>L2</b>	<b>C02</b>
11	<p><b>11b.</b> The water board of Karnataka planned to implement a resistance-based sensor to monitor the water level in the tanks to avoid wastage. The total resistance of the sensor is <math>5M\Omega</math> powered by a 12V battery. The alarm will be activated when the level reaches 5% of the total capacity. Predict the voltage to be provided by the sensor to the signal processor in order to stop the water inflow.</p>	<b>8 Marks</b>	<b>L3</b>	<b>C02</b>

	<b>12a.</b>	Depending on the mechanism by which electric current varies due to light, there are three types. Compare all three types.	<b>2 Marks</b>	<b>L2</b>	<b>CO2</b>
<b>12</b>	<b>12b.</b>	Priya developed an air-cored inductor-based proximity sensor to detect whether any object that comes within 5mm of the sensor. For the sensor, she used 5cm of 1mm thick copper wire and wound it to have 150 turns. Determine the output inductance from the sensor if the frequency used to drive the probe is 50kHz. Assume $A = 50\mu\text{H}$ , $k = 0.5\text{mm}^{-1}$ and permittivity of free space of $1.3 \times 10^{-6}\text{H/m}$ .	<b>8 Marks</b>	<b>L3</b>	<b>CO2</b>
		<b>Or</b>			
	<b>13a.</b>	A switch-based sensor can operate in two modes depending on the application. Compare both the modes of operation.	<b>2 Marks</b>	<b>L2</b>	<b>CO2</b>
<b>13</b>	<b>13b.</b>	Ravi is working on building a photodiode to achieve a near-perfect light sensor. He simulated the device to check his results prior to fabricating the sensor. As an expert, examine his device which produces a photocurrent of $-100\mu\text{A}$ and a leakage current of $2\text{nA}$ . The photodiode is reverse biased at 5V and measured at room temperature.	<b>8 Marks</b>	<b>L3</b>	<b>CO2</b>