

Model Question Paper

Fourth Semester BE Degree Examination

Sensors & Actuators for Robotics

Time: 3 Hours

Max. Marks: 100

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.*

Module -1			M	L	C
Q1	a.	Explain the classifications of sensors and Actuators	8	L2	CO1
	b.	Define Range, span, input and output full scale, resolution, and dynamic range	8	L2	CO1
	c.	A silicon temperature sensor has a range between 0 C and 90 C. The accuracy is defined in the data sheet as 0.5 C. Calculate the dynamic range of the sensor.	4	L3	CO3
OR					
Q2	a.	Explain the general requirements for interfacing sensors and actuators in a system	8	L2	CO1
	b.	Define sensitivity, Frequency response, response time, and bandwidth	8	L2	CO1
	c.	A loudspeaker is rated at 6 W and requires a minimum power of 0.001 W to overcome internal friction. What is its dynamic range?	4	L3	CO3
Module- 2					
Q3	a.	How mechanical Pressure Sensors are working? Explain with neat diagram	10	L2	CO2
	b.	Explain the construction and working of a metallic strain gauge with a neat diagram.	10	L2	CO2
OR					
Q4	a.	Explain the construction and working of capacitive accelerometers with diagrams.	10	L2	CO2
	b.	Explain the construction and working of a mechanical gyroscope with a neat diagram.	10	L2	CO2
Module – 3					
Q5	a.	Describe the operation of a CCD array for image sensing	8	L2	CO2
	b.	Explain the construction and working of capacitive microphone with a neat diagram	8	L2	CO2
	c.	A photomultiplier with 10 dynodes has a cathode coated with potassium to increase sensitivity. Calculate the thermally produced dark current at the cathode and at the anode at 25°C, assuming that each incoming photon is energetic enough to release six electrons and that each accelerated electron releases six electrons	4	L3	CO3
OR					
Q6	a.	Explain the working of Hall sensors for rotational sensing	8	L2	CO2
	b.	Explain how Photomultiplier is Working	8	L2	CO2
	c.	The Hall element's primary function is sensing of magnetic fields, but it can also sense any quantity related to the magnetic field. The geometry uses a silicon element with a Hall coefficient of $-10^2 \text{ m}^3/\text{A.s}$. The dimensions of the Hall element are $a = 2 \text{ mm}$, $b = 2 \text{ mm}$, and its thickness is $c = 0.1 \text{ mm}$. Calculate the response of the Hall element: (a) For magnetic flux densities from 0 to 2 T. This	4	L3	CO3

		is the range normally found in electric machines. What is the minimum field measurable if a digital voltmeter with a resolution of 2 mV is used to measure the Hall voltage? b) For flux from 0 μWb to 10 μWb .			
Module – 4					
Q7	a.	Explain the principle and operation of radar systems with a neat diagram.	8	L2	CO2
	b.	Describe the construction and working of a reflectance optical sensor with a neat diagram	7	L2	CO2
	c.	An alcohol sensor is made by deposition of a thin layer of tungsten trioxide (WO_3) nanoparticles on a substrate. To evaluate its performance, the resistance of the sensor is measured at two concentrations. At 100 ppm the resistance is 161 $\text{K}\Omega$, while at 1,000 ppm its resistance is 112 $\text{K}\Omega$. The resistance of the sensor in air in the absence of alcohol is 320 $\text{K}\Omega$. Calculate the sensitivity of the sensor in ohms/ppm	5	L3	CO3
OR					
Q8	a.	Explain the construction and working of a metal oxide CO sensor with a neat diagram.	8	L2	CO2
	b.	Describe the construction and operation of a thermal conductivity sensor.	7	L2	CO2
	c.	An uncompensated pH probe is used to sense the pH in a fish tank. (a) Calculate the voltage measured using a saturated calomel reference electrode if the water is neutral ($\text{pH} = 7$) and the sensor is calibrated at 20°C . (b) Calculate the error in the voltage reading of the sensor if the temperature increases by 15°C . What is the expected pH reading at 35°C ?	5	L3	CO3
Module – 5					
Q9	a.	Explain the construction and working of a BLDC motor with a neat diagram.	10	L2	CO1
	b.	Discuss the Principles of operation of Ultrasonic sensors and actuators.	10	L2	CO1
OR					
Q10	a.	Illustrate the construction and working of a stepper motor with a neat diagram.	10	L2	CO1
	b.	Explain the process of electroplating with a neat diagram	10	L2	CO1
