



MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

Reg. No.

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SECOND SEMESTER M.TECH. (CONTROL SYSTEMS)

END SEMESTER DEGREE EXAMINATION, APRIL/MAY - 2019

SUBJECT: ADVANCED SENSOR TECHNOLOGY [ICE 5233]

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates : *Answer ALL questions and missing data may be suitably assumed.*

- 1A What is the need for having a grounded guard for a monopolar capacitive probe?
- 1B For an Intake manifold temperature sensor of a gasoline engine, the rise time of its signal is inversely proportional to its bandwidth. The rise time (t_r) is 0.025 seconds & bandwidth is $(0.25/t_r)$. With the ambient temperature at 27°C & thermal resistance $5\text{k}\Omega$, compute magnitude of thermal noise as well as SNR if the average current passing through resistor is 0.2 mA. Assume that the sensor is faulty & is replaced with a new temperature sensor. This sensor has a rise time twice as that of the old sensor & bandwidth being $(1/5)^{\text{th}}$ of the rise time. For the same ambient temperature & a resistance of $12\text{k}\Omega$, compute the thermal noise magnitude and SNR for the same value of average current. ($K = 1.38 \times 10^{-23} \text{ JK}^{-1}$)
- 1C Suggest a sensor that can be used for accurate measurement of very low pressures at different temperatures without the need of thermal compensation. Mention the important properties of the suggested sensor.
- 1D With suitable applications, discuss the classification of industrial fibre optic sensors based on the sensing location.
- (2+3+2+3)
- 2A Write any two important properties of a scintillation material. With the help of neat diagram, explain the working of scintillation radio detector with photomultiplier.
- 2B A chemical reactor requires a rugged and contaminant resistant sensor for measuring the liquid as well as gas flow under varying temperature. Which sensor can be possibly used for this reactor? With a neat diagram, explain the working of this sensor.
- 2C What is the need to chemical sensors in modern industrial applications? Discuss the working of an amperometric chemical sensor.
- (4+3+3)
- 3A State the four important effects which form the basis for a magneto-strictive sensor. With neat sketch, brief the working of a magneto-strictive sensor.
- 3B With a neat diagram, describe the principle of working of a sensor which is used for evenly distributing the electric spark of a gasoline engine in light motor vehicles.
- 3C Mention any four important applications of MEMS sensors.
- 3D When a magnetic field is applied on a magneto-resistive metal, its internal resistance changes to $12 \text{ k}\Omega$ and internal magnetization changes by an angle of 66° . If the change in resistance is $1.5 \text{ k}\Omega$, calculate the resistance of the metal before it came under the influence of magnetic field.
- (4+2+2+2)
- 4A Derive an equation for the difference in optical path due to light propagation in opposite directions due

to sagnac effect. By taking the basis of sagnac effect, discuss the working of a gyroscope in which the propagating beams would undergo a change in frequency shift.

4B With block diagram representation, derive the equation for a soft sensor prediction model based on Principal Component Analysis (PCA) algorithm.

4C Describe a useful application of triboelectric motion detector.

(4+4+2)

5A With a neat diagram of a diesel engine management system (EMS), explain the role of different sensors used in the working of an automotive diesel engine.

5B What are acoustic sensors? Explain the functioning of a condenser acoustic microphone in feedback configuration.

5C Describe the principle of working of a sensor used for detecting dust composed of small submicron particles.

(5+3+2)
