Exam Date & Time: 21-May-2022 (10:00 AM - 01:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SIXTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, MAY 2022

ADVANCED SENSOR TECHNOLOGY [ICE 4055]

Marks: 50 **Duration: 180 mins.**

Descriptive

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Express in concise mathematical terms the use of a LIDAR sensor for 3D mapping. (2)

A)

B) Analyse the equivalent circuit of an electrode system used for measurement of biopotential from human skin. (3)

C) Evaluate and critique the research paper provided to you as a handout. (5)

2) Analyse mathematically the use of piezo elements in measurement of flow, of homogeneous clean fluids when placed diametrically opposite but axially separated by 30 and 60 degrees respectively. (4)

A)

B) Discuss the design considerations in design and use of photodiodes for spectroscopic applications. (3)

C) Analyse mathematically the immunity of the three-wire resistive transducer to lead wire resistance as compared to a two-wire sytem. (3)

3) How is a potential generated across an ion selective membrane? How is this integrable with conventional microfabrication technology? Design a pH sensor using this concept. (4)

A)

B) Describe mathematically the use of resistive elements for (a) measurement of strain and (b) measurement of temperature and hence analyse the decoupling of the two for measurement of strain. (3)

C) Design and analyse a circuit for linear scan amperometry. (3)

4) The groove period of a ruled grating is 400 nm. What is the maximum wavelength that this grating may diffract? 5000 grooves of this grating are illuminated with a monochromatic (5)

A) light of 530 nm, calculate the resolvable wavelength difference. (assume diffraction order as 1)

A setting of 50 scans to average and integration time of 100 ms is used to acquire a first order binding event of time constant 1 second at a wavelength of 530 nm. Draw the absorbance response likely to be observed and comment on the settings used. If the absorbance value at t=0 is 1 and at t=10s is 2, determine the ratio of initial intensity (at t=0) to final intensity (at t=10).

B) A Pt 100 with temperature coefficient of 0.00392/degree is used for measurement of temperature in the range 1-5V. Calculate the differential gain of the amplifier for the span 0 to 350 degree centigrade? (2)

C) Using a potentiometer and basic components develop a system to control speed of a motor.

A 150 ohms strain gauge is bonded to a steel bar which is subjected to a tensile load. Cross-sectional area of the bar is 0.5*10^-4 m^2 and young's modulus for the material is 200 GN/m^2 · If a load of 60kN produces a change of 1.5 ohms in the gauge resistance determine the gauge factor. (3)

5) An LVDT produces an output of 6 V (RMS) when its core is displaced by $0.4*10^{-3}$ mm. Assuming this to be in the linear range of operation where central core position is seen as 3 V (RMS), determine the sensitivity. If 10V voltmeter with 100 scale divisions is used to read the output, $2/10^{th}$ division can be estimated with this determine the resolution of the voltmeter. (3)

A)

B) Design an optical sensing system for measurement of refractive index (3)

C) Describe the basic building blocks of an optical sensing system. Explain the operation of an avalanche photodiode. (4)

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