



Mansoura University

Faculty of Engineering

Biomedical Engineering Program

Course Title: Sensors and effects

Date: Tuesday, 31/12/2019, 12:00 PM

Course Code: CSE352

Time allowed: 2 hours

Year: Level 300 students

Total mark: 50 Marks

Semester: First term 2019 / 2020

Final term exam

No. of pages: [2]

Examiner: Dr. Eman M. El-Gendy

- Assume Any Missing Data.
- Books and notes are not allowed.
- Attempt all the following questions.
- Total number of questions = 3.

Question 1:

(16 Marks)

- a) Explain the difference between: (8 Marks)
- i. Inductive **and** capacitive proximity sensors.
 - ii. AC **and** DC tachogenerator.
 - iii. Bimetallic strip **and** thermocouple.
 - iv. Dead zone **and** dead time of a sensor.
- b) A measuring sensor has a range from 10 to 150 units and its accuracy is specified as $\pm 0.1\%$ of the span. Calculate the error of the sensor? (3 Marks)
- c) A displacement sensor has an input range of 0 to 3 cm and a supply voltage $V_s = 0.5$ V. Results from a calibration experiment are given in the table below. Calculate the maximum nonlinearity error as a percentage of the full scale deflection? (5 Marks)

Displacement x (cm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0
Output voltage (mV)	0.0	16.5	32.0	44.0	51.5	55.5	58.0

Question 2:

(22 Marks)

- a) Explain the operation of: (6 Marks)
- i. Weighted resistor DAC.
 - ii. Hall effect sensor.
 - iii. Sigma-Delta ADC.

- b) A resistance wire strain gauge with $GF = 2.5$ is bonded to a steel structural member subjected to a stress of 120 MN/m^2 . The modulus of elasticity is 250 GPa . **Find** the percentage change in the value of the gauge resistance? (4 Marks)
- c) A steel cantilever is 300 mm long, 25 mm wide, and 5 mm thick.
- Calculate** the value of deflection at the free end of the cantilever when a force of 30 N is applied at this end. The modulus of elasticity for steel is 200 GPa .
 - An LVDT with a sensitivity of 0.6 V/mm is used. The voltage is read on a 20 V voltmeter having 100 divisions. Two-tenths of division can be read. **Calculate** the resolution of the LVDT.
 - Find** the minimum and maximum value of force. (9 Marks)
- d) A certain gas is trapped in a closed metal box which is subjected to variable temperature. Change in box size due to heat is negligible. **Which** of the following sensors can be used to measure the temperature of the gas: (potentiometer – limit switch – Bourdon tube – tachogenerator)? **Explain** your answer. (3 Marks)
[Hint: the general gas law is: pressure * volume / temperature = constant]

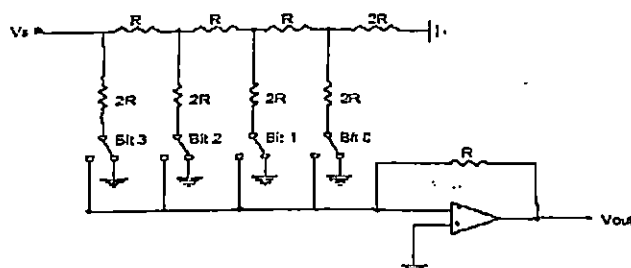
Question 3:

(12 Marks)

- a) A platinum RTD has resistance $R = 140 \Omega$ at 100°C and $R = 100 \Omega$ at 0°C . If the resistance increases to 280Ω , **Determine** the temperature? (3 Marks)
- b) A thermocouple has the cold junction at 20°C . **What** will be the thermal emf when the hot junction is at 200°C ? (3 Marks)

T ($^\circ\text{C}$)	0	20	200
emf (mV)	0	1.192	13.419

- c) **Find** the digital value of $V_{in} = 0.6 \text{ V}$ using successive approximation ADC if $V_{ref} = 1 \text{ V}$ assuming 10 bit resolution (show steps). (3 Marks)
- d) For the R-2R ladder DAC shown in fig.1, **Calculate** the analog output voltage when the switch positions are 1010, where $V_s = 10 \text{ V}$. (3 Marks)



Best Wishes,
Dr. Eman M. El-Gendy
Tuesday, 31/12/2019, 12:00 PM