



**Final-Term Exam.**

Assume any missing data....The exam is two pages.

\*Books & notes are not allowed.

**Attempt the following questions:**

**Max. Marks (50)**

**Question 1:**

**(23marks)**

(1-a) Describe the difference between:

**(8marks)**

- I. Deflection and Null Sensors.
- II. Bimetallic strip temperature sensors and RTD.
- III. Bourdon tube and manometers.
- IV. Weighted resistor and Resistor Quad DAC.

(1-b) A potentiometer which is used to measure the rotational position of a shaft has 850 turns of wire.

The input range is from  $-160^{\circ}$  to  $160^{\circ}$ . The output range is from 0 V to 12 V. Determine:

- I. The span.
- II. The sensitivity in volts/degree.
- III. The average resolution in volts.

**(3marks)**

(1-c) A load cell transducer has an input range of 0.0 to 10.0K lbs. Results from a calibration experiment are given in the table below.

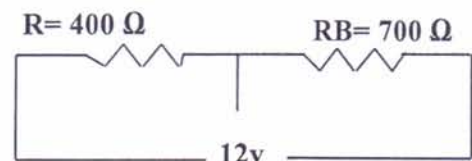
**(6marks)**

Weight x (K lbs)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Output voltage (mV)	0.0	18.0	24.5	38.0	42.0	58.5	70.0	74.5	82.0	85.0	90.0

Calculate the maximum non-linearity as a percentage of the full-scale deflection (f.s.d.)

(1-d) A strain gauge having a resistance of  $400 \Omega$  and gauge factor 2.5 is connected in series with a ballast resistance of  $700 \Omega$  across a 12v as shown in fig.1. Determine the change in the output voltage when a stress of  $150 \text{ MN/m}^2$  is applied the modulus of elasticity is  $200 \text{ GN/m}^2$ .

**(6marks)**



**Fig.1**

**Question 2:**

**(16marks)**

(2-a) Explain the theory and operation of:

**(3marks)**

- I. Eddy current proximity switches
- II. Thermocouples sensors.
- III. Fully decoded DAC.

(2-b) A certain gas is trapped in a closed metal box which is subject to variable temperature. Change in box size due to heat is assumed to be negligible small. If you are required to measure the

temperature of the gas given any of the following sensors (potentiometer, limit switch, untwist Bourdon, tachometer), which one would you use? Explain your answer.

[Hint: you may employ the general gas law: pressure \* volume/ temperature = constant]. (3marks)

(2-c) A platinum resistance thermometer has a resistance of  $150\ \Omega$  at  $100^\circ\text{C}$ . its resistance increases to  $250\ \Omega$  when it is in contact with a hot gas. Assume resistance to be  $100\ \Omega$  at  $0^\circ\text{C}$ . what is the temperature of this hot gas. (5marks)

(2-d) It is required to determine the temperature of a liquid in the range  $0^\circ\text{C}$  to  $100^\circ\text{C}$  where only rough accuracy is required. The situation might be the determination of the temperature of the cooling water for a car engine and its display as a pointer as moving across scale marked to indicate safe and unsafe operating temperature. Design a suitable temperature measurement system. (5marks)

### Question 3:

(15marks)

(3-b) For R-2R Ladder (DAC) as shown in fig.2.

Calculate the analog voltage value that outputs when the switches positions are 10101011. Where,  $v_s = 24\text{ v}$ . (4marks)

(3-c) For successive approximation ADC (10 bit ADC),  $V_{ref}=1\text{ volts}$ . Find the digital value

of  $V_{in}=0.65\text{ analog volts}$  (show steps). (6marks)

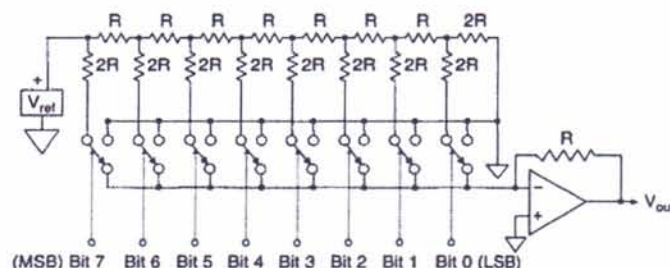


Fig.2.

(3-b) As in fig.3, what is the output voltage of the buffer amplifier? Assume the input impedance of the buffer amplifier is  $2.5\text{M}\Omega$  and the output impedance is  $30\Omega$ . (5marks)

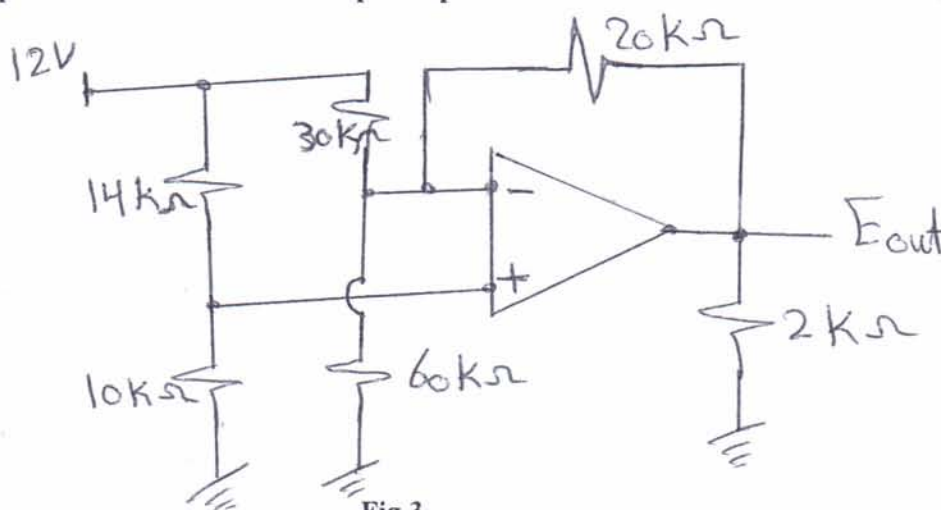


Fig.3.

With my best wishes,

Dr. Mahmoud M. Saafan,

12:00 PM, Tuesday, 15th Jan. 2019.