

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING UNIVERSITY EXAMINATIONS FOR DIPLOMA IN TECHNOLOGY (INSTRUMENTATION & CONTROL ENGINEERING)

ECI 2204

INSTRUMENTATION SYSTEMS

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2019

TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination -Answer Booklet, examination pass and student ID This paper consists of five Questions Attempt any THREE Questions.

Do not write on the question paper.

QUESTION ONE

- a) i) State the Law of intermediate metals as applied to thermocouples
 - ii) Explain with aid of diagram, the construction and operation of a thermocouple

(8 marks)

- b) Draw a diagram of Linear variable differential Transformer (LVDT) and explain its operation (5marks)
- c) A capacitor transducer is made up of two concentric cylindrical electrodes .The outer diameter of the inner electrode is 5mm and the inner diameter of the outer electrode is 5.2mm. Length of the electrode is 25mm, Calculate the change in capacitance if the inner electrode is moved a distance of 5mm. (3 marks)

d) A linear potentiometer having a resistance of $50k\Omega$ is connected to a supply of 12V . The slider is set to $\frac{1}{5}$ range of the arc length.

calculate

- i) the output voltage when the output terminals are left open circuit
- ii) the output voltage when a $20k\Omega$ load resistor is connected to the slider
- iii) the % loading error (4 marks)

QUESTION TWO

- a) Draw the block diagram of Successive Approximation Analog to Digital convertor and explain its operation (8marks)
- b) Derive the expression for the output voltage in figure 1

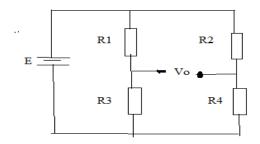


Figure 1 (4marks)

c) The bridge arrangement of figure 2 contains in its fourth arm a resistive strain gauge transducer of value R when unloaded. When loaded, the transducer resistance changes by ΔR depending on the load. If for a particular case $\Delta R = 5\Omega$, Determine the reading of the voltmeter (4 marks)

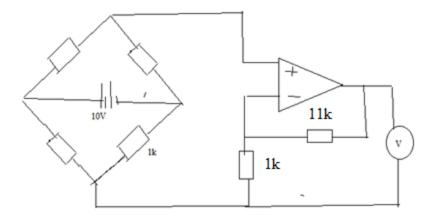


Figure2

- d) A 5 bit binary weighted DAC has a resistance of $160 \text{K}\Omega$ in the LSB position .The feedback resistor is $10 \text{k}\Omega$.The reference voltage is 12 V.Determine
 - i) the weight of the LSB digit
 - ii) the output voltage corresponding to an input of 11110
 - iii) the digital input equivalent for analog output of 8.25V
 - iv) the resistance of the MSB digit (4 marks)

QUESTION THREE

- a) Define the following terms;
 - I) piezo resistive effect
 - II) piezoelectric effect (2 marks)
- b) i) State any TWO effects of temperature on strain gauges
 - ii) State any TWO advantages of semiconductor strain gauges
 - iii) Describe, with the aid of a diagram the dummy gauge method of overcoming the effect of temperature on strain gauges (8 marks)
- c) i) With the aid of a well labeled diagram, describe the construction and operation of the drag cup tachogenerator
 - ii) A variable reluctance type tachometer has a 60 rotor teeth .The counter records 3600 counts per second .Determine the speed in revolution per minute

(10 marks)

QUESTION FOUR

- Explain what is meant by 'loading effect' as applied to instruments and state one method of overcoming loading effect
 (3 marks)
- b) A pressure transducer has a sensitivity of 1.5 mV/bar if correctly energized. The output impedance of the transducer is 200Ω and it is connected to a galvanometer with an internal resistance of 100Ω .If the galvanometer has a sensitivity of $15 \text{mm/}\mu\text{A}$ and the galvanometer spots deflects 100 mm.Determine the magnitude of the pressure being measured.(5 marks)
 - c) A remote temperature monitoring system comprises the components in table 1 with respective sensitivities and impedances If the thermocouple has a hot junction temperature of 50°C, Determine
 - i) the input voltage into the amplifier
 - ii) the output voltage from the amplifier
 - iii) the power developed in the indicator /recorder

(4 marks)

Table 1

component	sensitivity	impedances	
		input	output
Thermocouple	40μV/°C	-	20 Ω
Amplifier	1000V/V	10000 Ω	1000 Ω
Indicator/recorder	-	200 Ω	-
Total Cable		250 Ω	

- d) i) Draw a block diagram of an instrumentation system and Explain the function of each block
 - ii) Explain any TWO advantages of electronic instrumentation over mechanical types

(8 marks)

QUESTION FIVE

- a) Distinguish between x-t and x-y recorders and give an example of each (4marks)
- b) With the aid of a diagram and explain the operation of a strip chart recorder (8marks)
- c) Draw the block diagram of a digital storage oscilloscope and explainthe function of each block

(6 marks)

d) State any TWO advantages of Light Emitting Diodes

(2 marks