UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION MAY 2019

TITLE OF PAPER: **INSTRUMENTATION SYSTEMS**

COURSE CODE: **EEE428**

TIME ALLOWED: **THREE** HOURS

INSTRUCTIONS:

1. Answer all five (**5**) questions
2. Each question carries 20 marks.
3. Marks for different sections are shown in the right-hand margin.

This paper has 3 pages including this page.

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QUESTION 1

A) For a general form of measurement systems

(i) Draw a block diagram showing. (3 marks)

(ii) Give an explanation of all the various parts of your block diagram. (9 marks)

B) A thermocouple gives an output of $0.4mV/°C$. What would be size of an ADC required to be used to measure temperature from 0 - 100°C with a resolution of 0.2°C. (8 marks)

QUESTION 2

An a.c. bridge has in arm AB a 0.2 μF capacitor, in arm BC 500Ω resistor, in arm CD a 0.1H inductor in series with a 50Ω resistor and in arm DA an unknown inductor. The unknown inductor can be considered to be a pure inductance in series with a pure resistance. What is the value of this inductance and resistance if the bridge is balanced at a frequency of 1 kHz? (20 marks)

QUESTION 3

A) Most transducers produce a voltage output. However, if the measured signal is to be transmitted, then the output voltage of a transducer must be converted to current. Draw a simple circuit having a transducer and a voltage to current converter to illustrate how current can be used as the signal transmission variable. Label all components of your circuit and all signals. (12 marks)

B) An optical position encoder used on a robot arm axis have a 10:1 gear ratio, optical disk with 36-slit disk, and a 10-bit binary counter.

Calculate

(a) the resolution of the optical position encoder, (2 marks)

(b) the maximum allowable shaft motion to ensure that the counter never over-range, and (5 marks)

(c) the amount of shaft movement represented by a binary number 0110111. (1 marks)

QUESTION 4

A) In Figure 3, the amplifier-valve-positioner part of the system gives 12mm displacement per millivolt change in input. The feedback loop gives 0.08mV Explain why instrumentation amplifiers are said to special-purpose amplifiers dedicated to instrumentation applications. per millimeter change in displacement. What will be the instantaneous error signal produced when the reference signal is suddenly changed by 10mV? (6 marks)

B) What is the difference between photovoltaic and photoconductive cell sensing devices? (4 marks)

C) Explain why instrumentation amplifiers are said to special-purpose amplifiers dedicated to instrumentation applications. (6 marks)

D) In the design of a measuring instrument, when is a zero-span-inverting amplifier useful? Give a general equation that relates the input and output of a zero-span-inverting amplifier. (4 marks)

QUESTION 5

Explain how linearization of a sensing device can be made by

(a) Linearization using digital software (10 marks)

(b) Linearization using digital (logic) hardware (3 marks)

(c) Linearization using analog circuitry. (7 marks)