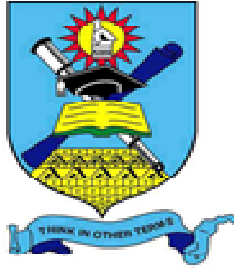


NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY



FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

B-Eng Hons Industrial and Manufacturing Engineering

Supplementary Examination

COURSE : **INDUSTRIAL INSTRUMENTATION AND CONTROL I**
CODE : **TIE 3114**
DATE : **JULY 2013**
DURATION : **3 HOURS**

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer **five(5)** questions, at least two from each section.
2. All question carry (20) marks
3. This paper contains six **(6)** questions.
4. There are **(4)** printed pages.
5. You will be penalized for not presenting your work neatly.

SECTION A

QUESTION 1

- a) Describe the three (3) sources of systematic errors that you know. [9]
- b) The terms repeatability and reproducibility mean approximately the same, but are applied in different contexts in regards to instruments. Explain the two terms in regards to the context they are used in. [4]
- c) Explain why it is normally desirable that the output reading of an instrument is linearly proportional to the quantity being measured. [2]
- d) Explain why it is important to understand hysteresis effects when dealing with instruments which exhibit those characteristics [5]

QUESTION 2

- a) Explain what is meant by the following giving examples:
 - (i) Active instruments. [2]
 - (ii) Passive instruments. [2]
- b) Discuss the relative merits of these two classes of instruments. [4]
- c) You work at a foundry where the temperature of the molten metal is measured by deeping a resistance temperature detector on the cupola spout when the molten metal is being poured into the ladle. There have been many instances where workers have been burnt while using the current system. The company engineer assigns you to design a new system which is safer.
 - i) What instruments are you going to use? [2]
 - ii) Explain using the aid of diagrams how your measurement system will function. [4]
- d) You have been assigned to work on an oil rig in the Kalahari Desert that has blown up. Upon assessment of the rid you discover that the temperature measuring device was also blown up. You realise that you came with a thermistor, voltmeter, ammeter, resistors of different resistances and a torch cell. The site engineer of the rig keeps water for drinking in a fridge and has a two plate stove for cooking.
 - i) Design a temperature measuring instrument using the equipment you have. [4]
 - ii) Explain how you will calibrate the instrument [2]

QUESTION 3

- a) Explain using diagrams the difference between the two groups of liquid level measuring devices [6]
- b) State three advantages of using a flow nozzle meter [3]
- c) Describe with aid of diagrams the principle of operation of a coriolis flow meter [5]
- d) Zimbabwe Sugar Refineries (ZSR) operates from two plants. Sugar is loaded into the trucks using a conveyer belt in one plant and weighed on the next plant using a weighbridge. The process is time consuming as weighing is a non value adding activity and many cases have been reported where drivers offload sugar from the trucks before they get to the

weighbridge. With aid of diagrams design a weighing system which will enable sugar to be weighed as it is being loaded onto the trucks.

[6]

SECTION B

QUESTION 4

- a) What is an actuator? [2]
- b) Discuss the factors you would consider when making a choice between hydraulic and pneumatic actuators. [5]
- c) Given that $R_1 = 24K\Omega$, $R_2 = 30K\Omega$ and $R_3 = 64K\Omega$

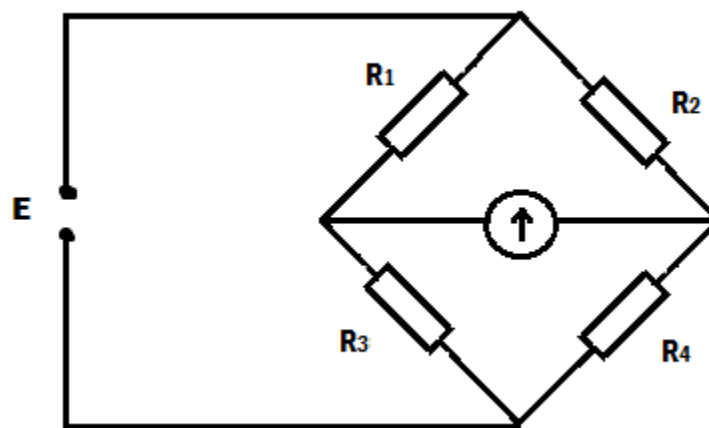


Figure Qu4: Wheatstone Bridge

Calculate the value of R_4 assuming that the flow into the galvanometer of the Wheatstone bridge is zero. (The d.c supply may be assumed to be negligible) [4]

- d) Describe the operation and construction of the transducers listed below.
 - i. Tacho generator [3]
 - ii. Piezoelectric transducer [3]
 - iii. Thermistor [3]

QUESTION 5

- a) A 1 Watt wound potentiometer of 500Ω formed by 150 turns of wire has a mechanical rotation of 285° and an electrical rotation of 265° . It is connected to a 20V supply.
 - i. Check that the power consumption of the coil has not been exceeded. [2]
 - ii. Find its resolution. [2]
 - iii. Find the Transfer function. [2]

- iv. Find the Dead-band and hence find [2]
- v. Hence find its output voltage when spindle has rotated 120° from the stop at 0V stop end.(assume wiper draws negligible current) [2]

- b) Write a ladder logic program to switch on a motor when the start switch is momentarily activated, with the motor remaining on for 50 seconds. At the end of that time a second motor is to be switched on for a further 50 seconds. A third motor is to be switched on 10 seconds before the second motor switches off and remain on for 50 seconds. The cycle is to repeat itself unless a stop switch has been activated. [10]

QUESTION 6

- a) Define resolution. [2]
- b) Given that an 8 bit microcontroller based control system is used for angular positioning for a satellite and the satellite can swiue through an angle of 360° . Calculate the possible resolution that can be achieved using such a microcontroller. [3]
- c) What makes the stepper motor the most preferred actuator for microcontroller based positioning systems? [5]
- d) Explain the following terms as applied to serial data communication:-
 - i) Simplex [2]
 - ii) Half duplex [2]
 - iii) Full duplex [2]
- e)

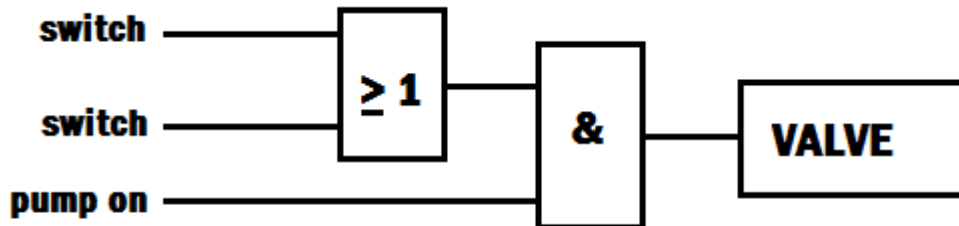


Figure Q6: Valve Operation Control

Given the block diagram in Figure Q6 for the control of a valve operation, write an equivalent of the program in;

- i) Ladder logic. [2]
- ii) Logic gate format. [2]

END OF EXAMINATION .