# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

## FACULTY OF INDUSTRIAL TECHNOLOGY

## DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

# BACHELOR OF ENGINEERING (HONOURS) DEGREE IN INDUSTRIAL AND MANUFACTURING ENGINEERING

## FIRST SEMESTER EXAMINATION DECEMBER 2011

## INDUSTRIAL INSTRUMENTATION AND CONTROL

COURSE CODE - TIE 3114

## **EXAMINATION DURATION 3 HOURS**

### **INSTRUCTIONS TO CANDIDATE**

- 1. Answer Five (5) questions at least one from each section
- 2. Each Question carries (20 marks) and there are Six Questions

#### SECTION A

#### **QUESTION 1**

a) Briefly explain the following errors:

	i)	Zero drift.	[2]
	ii)	Insertion error.	[2]
b)	Why	is it important to know the following properties of an instrument?	
	• \		

- i) Range. [2] ii) Sensitivity. [2]
- c) In any general measurement situation, it is very difficult to avoid modifying inputs. Which techniques are used to minimise their effect on the final output measurement? [8]
- d) The voltage across a resistance  $R_5$  in the circuit of Figure Q1 is to be measured by a voltmeter connected across it. If the voltmeter has an internal resistance ( $R_m$ ) of 4750 $\Omega$  what is the measurement error? [4]



Figure Q1 Measurement circuit

#### **QUESTION 2**

a) A load cell is calibrated in an environment at a temperature of 21°C and has the following deflection/load characteristic:

Load (kg)	0	50	100	150	200
Deflection (mm)	0.0	1.0	2.0	3.0	4.0

When used in an environment at 35°C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200
Deflection (mm)	0.2	1.3	2.4	3.5	4.6

[4]

[4]

- i) Determine the sensitivity at 21°C and 35°C.
- ii) Calculate the total zero drift and sensitivity drift at 35°C.

- iii) Hence determine the zero drift and sensitivity drift coefficients (in units of μm/°C and (μm per kg)/(°C)).
- b) You are using the instrument in Figure Q2 and you feel its sensitivity is very low. Suggest how you can improve its sensitivity. [4]
- c) In what ways can the act of measurement cause a disturbance in the system being measured?

[4]

[4]



Figure Q2 Measurement system

#### SECTION B

### **QUESTION 3**

a)	Explain the operation of the following sensors:	
	i) Load cell.	[4]
	ii) Bubbler devices.	[4]
b)	Explain with aid of diagrams principle of operation of an optical pyrometer.	[6]
c)	What are the environmental concerns that have to be catered for when using differential p	ressure
	detector.	[6]

### **QUESTION 4**

- a) A pressure gauge located at the base of an open tank containing a liquid with a specific weight of 13.6 kN/m<sup>3</sup> registers 1.27 MPa. What is the depth of the fluid in the tank? [4]
- b) Explain with aid of diagrams the principle of operation of an Electromagnetic flow meter. [6]
- c) Explain with aid of diagrams how you can use load cells to monitor the level of a liquid in a tank.
  [6]
- d) Give two advantages and two disadvantages of a venturi meter.

#### SECTION C

#### **QUESTION 5**

The company you were attached to gets a tender to design the new highly automated Delta Beverages plant in Bulawayo. The projects manager assigns you to design a boiler feeding system that will maintain the temperature, water level and pressure on the boiler constant.

- a) Select the suitable instruments you will use for the system and give a reason why you chose them. [9]
- b) Using a block diagram show how your sensors will be connected to the control system. [5]
- c) Explain how the changes in the environment will affect your system. [6]

#### **QUESTION 6**

a) The company you were attached to is losing production time in trying to measure the level of a conductive instrument using the dipping system.

	i)	Suggest an instrument that will replace the dipping system to reduce losses in produc	tion
		time.	[2]
	ii)	Explain its principle of operation using diagrams.	[8]
b)	What	t are the disadvantages of using the instrument given in Question 6a(i)?	[4]
c)	Instru	uments are classified as active or passive instruments. In which category does	the
	instru	ument fall?	[2]
d)	What	t are the two advantages that active instruments have over passive ones?	[4]

#### **END OF EXAM**