



**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION  
COUNCIL (TVET CDACC)**

**Qualification Code** : 071606T4MCT  
**Qualification** : Mechatronics Level 6  
**Unit Code** : ENG/OS/MC/CR/04/6/A  
**Unit of Competency** : Perform mechatronics systems instrumentation and control

**WRITTEN ASSESSMENT**

**INSTRUCTIONS TO CANDIDATE**

1. You have **THREE** hours to answer all the questions.
2. Marks for each question are indicated in the brackets.
3. The paper consists of **TWO** sections: A and B.
4. Do not write on the question paper.
5. A separate answer booklet will be provided.

**SECTION A (40 MARKS)**

*(Answer ALL the questions in this section)*

1. State five categories of PPE (5 Marks)
2. Name two major types of control systems (2 Marks)
3. Highlight two comparison of a sensor and a transducer. (4 Marks)
4. Explain what an operation and maintenance manual is. (2 Marks)
5. List four major the components of a hydraulic system. (4 Marks)
6. Differentiate between positive and negative feedback (4 Marks)
7. State three functions of a controller in a control system (4 Marks)
8. Define the following terms s used in instrumentation (4 Marks)
  - a) Desired value
  - b) Manipulated value
9. Outline four significance of developing system models when designing control systems. (4 Marks)
10. Outline two items that are found on a technical report. (2 Marks)
11. Differentiate between the following terms as used in instrumentation systems. (4 Marks)
  - a) Resolution and accuracy.
  - b) Repeatability and reproducibility
12. Highlight two importance of patenting. (2 Marks)

**SECTION B (60 MARKS)**

*(Answer any THREE questions in this section)*

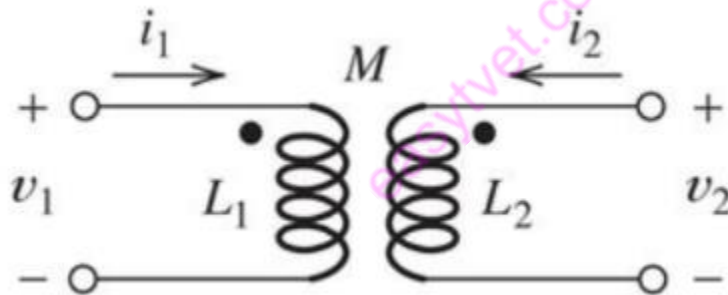
13.

a) The government of Kenya wishes that all public service vehicles operate at 80km/h. With the aid of well labelled block diagram, explain the control system, given speed governor, engine and flywheel. (10 Marks)

b) Explain how capacitive sensing works, and give an example of its application. (10 Marks)

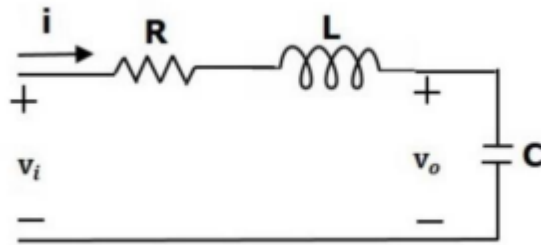
14.

a) Two induction coils are wound on the same form as shown in Figure 1. Explain, in your own words, what causes the self-inductances  $L_1$  and  $L_2$ , and the mutual inductance  $M$ . Explain the significance of the black dots shown in Figure 5. (5 Marks)



*Figure 1*

b) Consider the following electrical system as shown in the following figure. This circuit consists of resistor, inductor and capacitor. All these electrical elements are connected in series. The input voltage applied to this circuit is  $v_i$  and the voltage across the capacitor is the output voltage  $v_o$



- i. Develop second order differential equation equating the input and the output of the electrical system. (5 Marks)
  - ii. Develop the transfer function for the system. (5 Marks)
- c) A spring balance has its deflection measured for a number of loads and gave the following results. Determine its sensitivity. (5 Marks)

Load in kg	0	1	2	3	4
Deflection in mm	0	10	20	30	40

15.

- a) A pressure measurement system (a diaphragm sensor giving a capacitance change with output processed by a bridge circuit and displayed on a digital display) is stated as having the following characteristics. Explain the significance of the terms:

(10 Marks)

Range: 0 to 125 kPa and 0 to 2500 kPa

Accuracy:  $\pm 1\%$  of the displayed reading

Temperature sensitivity:  $\pm 0.1\%$  of the reading per  $^{\circ}\text{C}$

- b) A platinum resistance coil is to be used as a temperature sensor and has a resistance at  $0^{\circ}\text{C}$  of  $100\ \Omega$ . It forms one arm of a Wheatstone bridge with the bridge being balanced at this temperature and each of the other arms also being  $100\ \Omega$ . If the temperature coefficient of resistance of platinum is  $0.0039\ \text{K}^{-1}$ , what will be the

output voltage from the bridge per degree change in temperature if the supply voltage is 6.0 V? (5 Marks)

c) List five elements of a close loop system. (5 Marks)

16.

a) Measurement signals often have to be transmitted over quite large distances from the place of measurement to a display unit and/or a process control unit. Discuss five methods used for such transmission. (10 Marks)

b) In carrying out the maintenance of a measurement system, the most important aid is the *maintenance manual*.

i. Describe five information contained in a maintenance manual. (5 Marks)

ii. Identify five activities carried out during maintenance. (5 Marks)