NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF FIBRE AND POLYMER MATERIALS ENGINEERING

INSTRUMENTATION AND CONTROL

TFE 2207

Second Semester Examination Paper

March 2025

This examination paper consists of 2 pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements: **NIL**

Examiner's Name: **Mrs S Moyo**

INSTRUCTIONS

1. Each question carries **25 marks.** This paper contains **five** questions.
2. The first fifteen minutes should be spent reading the question paper and making notes.
3. **Do not** open your answer sheet until told to do so.
4. Marks will be awarded for skill in appreciating the scope of questions, clarity of argument and conciseness of presentation as well as for the knowledge displayed by a candidate.

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**

QUESTION 1

a) Define the following terms:
   i. System
   ii. Measurement element
   iii. Transducer
   iv. Actuator
   v. Sensor

[5 Marks]

b) Discuss the various types of errors encountered in measurement and instrumentation and detail how each may arise. **[10 Marks]**

c) Giving relevant examples, discuss the constituent elements of an instrumentation system **[10 Marks]**

QUESTION 2

a) Explain two effects stated below and how they are applied in thermocouple thermometry.
   i. Seebeck effect **[3 Marks]**
   ii. Peltzier effect **[3 Marks]**

b) Using a temperature measurement instrument of your choice; describe how the act of measurement can be a source of systematic errors. **[4 Marks]**

c) State the Zeroth law of Thermodynamics and explain how it is linked to most forms of thermometry/temperature measurement. **[5 Marks]**

d) The figure below shows a popular temperature measuring device. What principle does this thermometer apply for it to be effective as a non-contact temperature measuring device which made it popular for measuring temperature during the covid-19 pandemic. **[10 Marks]**

QUESTION 3

a) Define all the process variables and state their units of measurements **[5 Marks]**

b) Explain the construction and working principle of a venturimeter/ venture flow meter **[10 Marks]**

c) Employing well labelled diagrams, discuss the orifice flow meter as well different types of orifice plates used in flow rate measurement clearly stating their respective applications. **[10 Marks]**

QUESTION 4

a) State the objectives of a control system **[5 Marks]**

b) With the aide of diagrams, discuss the following control strategies

i. Open loop control
ii. Feed forward control
iii. Feedback control
iv. On/off control
v. Modulating feedback control

[20 Marks]

QUESTION 5

a) A concentric cylindrical capacitance probe is used to measure liquid level in a storage vessel having uniform cross-sectional area.

i. State the principle upon which the device is based.
ii. Describe, with the aid of diagrams, the construction of such a device and the operation of the measuring circuit. **[14 Marks]**

b) Give two precautions which must be observed at the specification stage to enable a capacitance probe to be used with highly conductive fluids which are subject to variations in temperature. **[6 Marks]**

c) Figure Q4.1 shows a spring-mass-damper system.

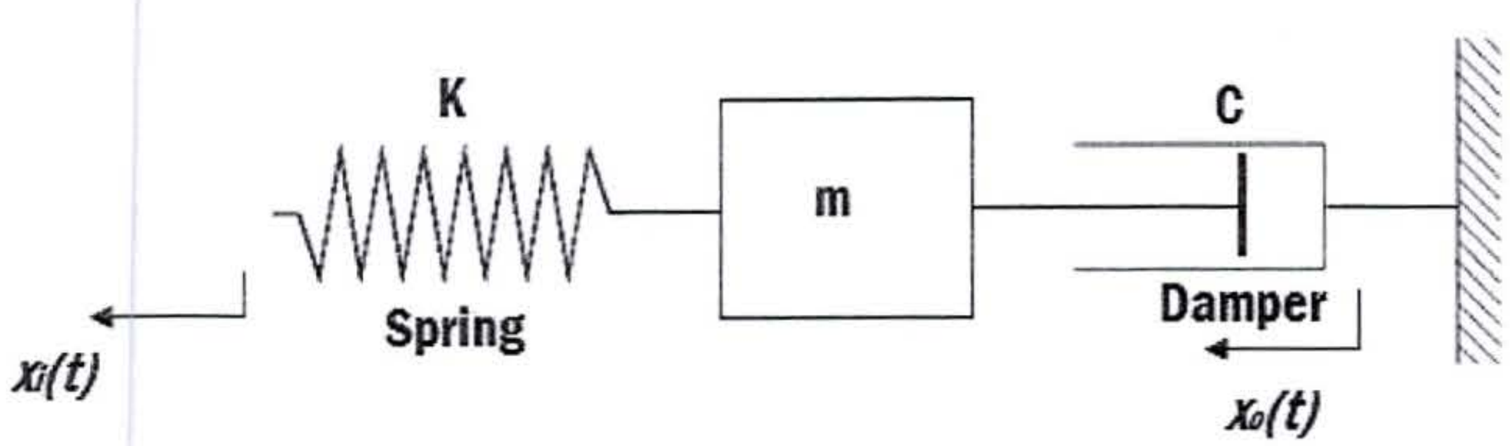

Figure Q4.1 Spring, Mass, Damper System.

(i) Find the differential equation relating the displacements $x_i(t)$ and $x_o(t)$ for the spring-mass-damper system shown in FigQ4.1. **[5 Marks]**

END OF QUESTION PAPER