



THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY

Diploma In Technology (Electrical Power Engineering) – DEPE 4

Diploma in Technology (Computer Science Engineering) – DCSE 4

Diploma in Technology (Telecommunication and Information Engineering) – DTIE4

EEC 2205

INSTRUMENTATION TECHNOLOGY I

SERIES: FEBRUARY 2011 SERIES

TIME: 2 HOURS

Instructions to Candidates:

1. You are required to have the following for this examination;
 - Answer booklet
 - A non-programmable scientific calculator
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions.

(COMPULSORY)

Question ONE

- a) Draw a block diagram of an instrumentation system and explain the function of each part. (6 marks)
- b) With respect to static characteristics of transducers, explain the following terms:
i) Reliability
ii) Reproducibility
iii) Hysteresis
iv) Operating Range (4 marks)
- c) Differentiate between the following:
i) Transducers and Inverse Transducers
ii) Active and Passive Transducers
iii) Primary and Secondary Transducers. (6 marks)
- d) State and explain any THREE factors that influence the choice of a transducer. (9 marks)
- e) State:
i) Any TWO advantages of Potentiometers
ii) Any THREE disadvantages of semi-conductor strain gauges.

(ANSWER ANY OTHER TWO QUESTIONS)

Question TWO

- a) i) Distinguish between bonded and unbonded strain gauges.
ii) With the aid of a suitable notations derive the expression for the gauge factor of strain gauge element. (14marks)
- b) A strain gauge having a resistance of 120Ω is mounted on a steel cantilever beam at a distance of 0.15m from the free end. An unknown force F applied at the free end produces a deflection of 12.7mm of the free end. The change in gauge resistance is found to be 0.152Ω . The beam is 0.25m long with a width of 20mm and a depth of 3mm. The young modulus for steel is 200GN/m^2 . Determine the gauge factor.

Question THREE

- a) i) State the requirement to be fulfilled for a conducting material to be used in a resistance temperature detector (RTD).
ii) State any THREE salient features of thermistors.
iii) Explain how a thermocouple output may be measured using a millivoltmeter. (9 marks)
- b) A thermistor has a resistance of 3980Ω at the ice point (0°C) and 794Ω at 50°C . The resistance temperature relationship is given by $R_T = aR_o \exp\left(\frac{b}{T}\right)$
- Determine:
- i) The constants a and b
ii) The range of resistance to be measured in case the temperature varies from 40°C to 100°C . (7 marks)
- c) A platinum thermometer has a resistance of 100Ω at 25°C . Determine:
- i) Its temperature at 65°C if the platinum has a temperature co-efficient of 0.0039°C .
ii) If the thermometer has a resistance of 150Ω , determine the temperature. (4 marks)

Question FOUR

- a) i) With the aid of a circuit diagram, explain the operation of a linear variable differential transformer, showing clearly the output voltage variation.
ii) State any TWO advantages and TWO disadvantages of a Linear Variable Differential Transformer (LVDT). (12marks)
- b) A steel cantilever of dimensions 0.25m long, 20mm wide and 4mm thick. Determine:
- i) the value of deflection at the free end for the cantilever when a force of 25N is applied at this end. The modulus of elasticity is 200GN/m^2 .
ii) If an LVDT with a sensitivity of 0.5V/mm is used in conjunction with the cantilever system. The voltage is read on a 10V voltmeter having 100 divisions. The resolution of the voltmeter is 0.02V .
iii) Determine the minimum and maximum value of force that can be measured with this arrangement. (8 marks)

Question FIVE

- a) i) State any TWO advantages and any TWO disadvantages of capacitive Displacement sensors.
- ii) Explain briefly how capacitive transducers may be used to measure the following:
- I) Pressure
 - II) Humidity in gases
- (10marks)
- b) i) State any THREE uses of piezoelectric transducers.
- ii) A barium titanate pickup has the dimensions 5mm x 5mm x 1.25mm. The force acting on it is 5N and the charge sensitivity of the crystal is 150pC/N. Given that the permittivity of barium titanate is 12.5×10^{-9} F/m and its modulus of Elasticity is 12×10^6 N/m². Determine:
- I) The strain
 - II) The charge
 - III) The capacitance of the crystal.
- (10marks)