

Cork Institute of Technology

Higher Certificate in Engineering in Mechanical Engineering - Stage 1
(National Certificate in Engineering in Mechanical Engineering – Stage 1)

(NFQ – Level 6)

Summer 2005

Electrotechnology and Instrumentation

(Time: 3 Hours)

Answer **FIVE** questions, at least **TWO** from each Section.

All formulae and calculations must be shown.

Examiners: Mr. R. Simpson
Mr. J. Connolly
Mr. S. Cotter

Section A (*Electrotechnology*)

Q1. (a) Define or explain the terms: resistivity and temperature coefficient of resistance.

(4 marks)

(b) Calculate the electrical resistance of a copper cable of length 2.0 m and cross-sectional area $0.8 \times 10^{-6} \text{ m}^2$ that is used in a sensing element.

If the cable takes a current of 2.40 A, what is the potential difference across the cable?

Resistivity of copper = $1.72 \times 10^{-8} \Omega \text{ m}$. (8 marks)

(c) A platinum resistance thermometer indicates 105.00Ω at a room temperature of 15°C . Calculate its resistance at (i) 0°C , and at (ii) 60°C .

Temperature coefficient of resistance for platinum = $3.93 \times 10^{-3} \text{ K}^{-1}$. (8 marks)

Q2. (a) State Kirchoff's Circuit Laws (6 marks)

(b) Three resistors of resistance 20Ω , 5Ω and 4Ω connected in parallel are in turn connected in series with a resistor of 4Ω and powered by a 24 V d.c. power supply.

Draw the circuit diagram.

What is the equivalent resistance of the parallel branch?

What is the external resistance of the circuit?

What is the circuit current and the current in each of the parallel resistors? (14 marks)

Q3. (a) Describe how a galvanometer may be converted into a voltmeter. (6 marks)

(b) A galvanometer has a coil of resistance 75 ohms and can take a maximum current of 3 mA. It is to be converted into a voltmeter to read up to 10.00 volts.

What minimum multiplier resistance is required? (14 marks)

Q4. (a) Describe the construction and operation of the Wheatstone bridge circuit as an accurate method for the measurement of electrical resistance. (12 marks)

(b) A Wheatstone bridge is used to measure the value of an unknown resistance.

The value of R_2 was 5.00 ohms (a standard resistor) and the bridge was balanced when the uniform resistance wire of R_3 was 60.0 cm and R_4 was 40.0 cm.

Calculate the value of the unknown resistance. (8 marks)

Section B (*Measurement & Instrumentation*)

Q5. (a) Define or explain, with the aid of diagrams and examples, the meaning of the following measurement terms: Accuracy, Precision, Range, Span, and Resolution. (8 marks)

(b) Define or explain, with the aid of diagrams and examples, the meaning of the following calibration-type errors: Zero error, Proportionality error, maximum Non-linearity error, and Hysteresis error. (12 marks)

Q6. (a) Draw a block diagram of the elements in a general measurement system. Explain the function of each element and give one example of each. (4 marks)

(b) Describe the construction and operation of a capacitive type sensor element for the measurement of pressure. (6 marks)

- (c) A metal wire strain gauge has a nominal resistance of $120.00\ \Omega$ and a gauge factor of 2.0. What will be the change in resistance produced if the gauge is subjected to a strain of 0.10 %? (10 marks)

Q7. Describe fully, with the aid of diagrams, a laboratory experiment that you have performed on the calibration of either a Bourdon pressure gauge or a load cell. (20 marks)

Q8. (a) Give an example of a signal converter that could be used for each of the following signal conversions:

- (i) A small displacement to a bigger displacement
- (ii) A small rotation to a bigger rotation
- (iii) A small potential difference to a bigger potential difference
- (iv) A resistance change to a potential difference change.

marks)

(10

(b) State the main advantages and disadvantages of the following signal transmitters: mechanical, electrical, hydraulic, pneumatic, electromagnetic, and fibre optic.

(8 marks)