



**THE KENYA POLYTECHNIC UNIVERSITY  
COLLEGE**

---

**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**

**HIGHER DIPLOMA IN ELECTRICAL ENGINEERING**

**END OF YEAR II EXAMINATIONS**

**NOVEMBER 2007**

**ELECTRICAL MEASUREMENTS**

**3 HOURS**

**INSTRUCTIONS TO CANDIDATES:**

You should have the following for this examination:

Answer booklet

Non-programmable calculator/ New Mathematical tables

Answer any FIVE of the following EIGHT questions.

All questions carry equal marks and the maximum marks for each part of a question are as shown.

This paper consists of 4 printed pages.

**© 2007, The Kenya Polytechnic Examinations Office**

---

1. (a) Explain the meaning of the following terms as used in Electrical measurements:

- (i) Working standards
  - (ii) Secondary standards
  - (iii) Primary standards
- (6 marks)

(b) Derive the dimensional equations for the following quantities in terms of the fundamental units using EMU system of units:

- (i) Magnetizing force
  - (ii) Charge
  - (iii) Capacitance
- (6 marks)

(c) It is suspected that an error has been made in the derivation of the

expression: 
$$I = \frac{E\omega M}{\sqrt{(\omega^2 M^2 + R_1 R_2)^2 + \omega^2 L_1 R_1^2}}$$
 where  $I$  is the current in the

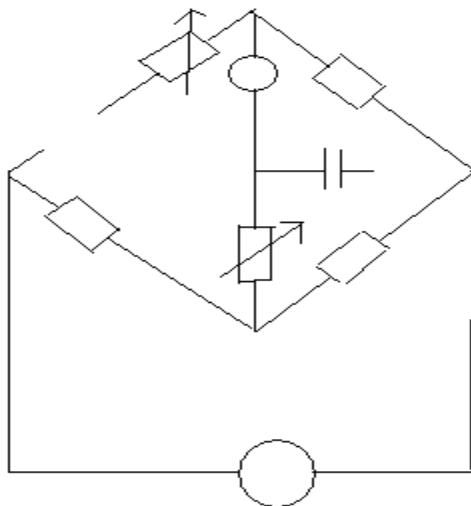
circuit;  $E$  the voltage,  $\omega$  angular velocity;  $M$  mutual inductance,  $L_1$  self inductance and  $R_1$  and  $R_2$  resistances. Ascertain if this is so and, if necessary, make a correction to ensure that the equation is dimensionally correct. Use dimensional analysis to check if the equation is correct.

(8 marks)

2. (a) State the three detectors commonly used for a.c bridges. (3 marks)

(b) (i) State the TWO disadvantages of Anderson's bridge. (2 marks)

(ii) Derive the equations for  $L_1$  and  $R_1$  in terms of other components in Figure 1 and hence determine their values. (15 marks)



**Figure 1**

3. (a) Explain the reasons behind the testing of bar specimens. (4 marks)
- (b) Describe with the aid of circuit diagrams the determination of B-H curve using step by step method. (12 marks)
- (c) The constant of a given magnetic potentiometer is obtained by the aid of a coil of 300 turns in which a current of 0.6A is reversed. The resulting throw of the galvanometer is 157 scale divisions. It is then used to measure the magnetic potential difference between two points and the throw is 304 divisions. Find the magnetic potential difference. (4 marks)
4. (a) State THREE disadvantages of multipliers when used with instrument transformers. (6 marks)
- (b) Define the following terms as used in instrument transformers:
- (i) Nominal ratio (ii) Turns ratio
- (iii) Ratio connection factor (3 marks)
- (c) A current transformer has a single turn primary and a 200 turns secondary winding. The secondary supplies a current of 5A to a non-inductive burden of 1 ohm resistance. The requisite flux is set up in the core by an mmf of 80A. The frequency is 50Hz and the net cross-sectional area of the core is 1000mm<sup>2</sup>. Calculate:
- (i) The transformation ratio
- (ii) The phase angle
- (iii) The flux density in the core.
- Neglect the effect of magnetic leakage, iron losses and copper losses)
- (11 marks)
5. (a) With the aid of RLC series circuit and phasor diagram, describe the principle of working of the Q meter. (12 marks)
- (b) Explain how the Q-meter may be used to measure:
- (i) Inductance (ii) Effective resistance (4 marks)
- (c) When a coil of resistance 10Ω is connected in the test terminals of the Q-meter, resonance occurs at a frequency of 1MHz with the tuning capacitor

set at 65pF. Calculate the percentage errors introduced in the calculated value of Q if a resistance of  $0.02\Omega$  is connected across the oscillator circuit.

(4 marks)

6. (a) State any TWO basic components of a magnetic tape recorder. (2 marks)
- (b) Explain the principle of operation of a magnetic tape recorder. (8 marks)
- (c) Describe the following methods of recording:
- (i) Marking with ink filled stylus.
  - (ii) Optical marking method. (7 marks)
- (d) A tape receives 12000 members per second. The tape speed is 1.5m/s. Calculate the number density of the tape. (3 marks)
7. (a) Define the following as applied to humidity:
- (i) Absolute humidity
  - (ii) Relative humidity (4 marks)
- (b) Describe with the aid of a diagram the operation of a resistive hygrometer. (10 marks)
- (c) Explain the operation of a capacitive microphone. (6 marks)
8. (a) (i) Explain the drawback encountered when using substitution method of resistance measurement. (2 marks)
- (ii) Explain using a circuit diagram the substitution method of resistance measurement. (10 marks)
- (b) A Wheatstone bridge whose ratio arms are  $1000\Omega$  and  $100\Omega$  respectively is used to measure an unknown resistance of  $25\Omega$  using two galvanometers. Galvanometer 'A' has a resistance of  $50\Omega$  and a sensitivity of  $200\text{mm}/\mu\text{A}$  while galvanometer 'B' has values of  $600\Omega$  and a sensitivity of  $500\text{mm}/\mu\text{A}$ .
- (i) Calculate the ratio of sensitivities
  - (ii) Which of the galvanometers is more sensitive to a small unbalance on this bridge? (8 marks)