ELECTRICAL ENGINEERING SCIENCE 1
DME 110
MARCH/APRIL 2010 SERIES

THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

DEPARTMENT OF MEDICAL ENGINEERING

DIPLOMA IN MEDICAL ENGINEERING

END SEMESTER EXAMINATION

TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE.

You should have the following for this examination.

- Answer booklet
- Scientific Calculator
- Drawing instruments

This paper consists FIVE questions.
Answer question ONE and any other TWO questions.
Question ONE carries 30 marks, all other questions carry 20 marks each.

1(a). Rewrite the following as indicated:

I. 1000pF = ----------nF
II. 0.02 μF=----------pF
III. 5000 KHz = ---------- MHz
IV. 47 KΩ = ---------- MΩ

V. 0.32mA = ---------- μA (5 marks)

(b)(i). An electric heater consumes 1.8MJ when connected to a 250V supply for 30 minutes. Find the power rating of the heater and the current taken from the supply. (4 marks)

(ii). Draw the symbols for a fixed resistor and a variable resistor as used in electrical circuit diagrams. (2 marks)

(iii). What current must flow if 0.24 coulombs is to be transferred in 15mS. (2 marks)

(c). The P.d's measured across three resistors connected in series are 5V, 7V and 10V, and the supply current is 2A. Determine
(i). The supply voltage
(ii). The total circuit resistance
(iii). The values of the three resistors (6 marks)

(d). Calculate the equivalent capacitance of two capacitors of 6 μ F and 4μF connected:
(i). In parallel
(ii). In series (4 marks)

(e). A 12μF capacitor is required to store 4J of energy. Find the p.d to which the capacitor must be charged. (2 marks)

(f). Give one example of a secondary cell and list FOUR practical applications of secondary cells. (5 marks)

2(a). State "ohm's law" (3 marks)

(b)(i). With the aid of a circuit diagram illustrate resistors of value 10Ω, 5Ω and 20Ω connected in parallel and drawing a current of 12A from the supply.

(ii). If the currents 1_1,1_2, and 1_3 flow in the 10Ω,5Ω and 20Ω resistors respectively, Calculate the value of 1_2. (5 marks)

(c). The equivalent resistance of two resistors connected in series is 90Ω. When these resistors are connected in parallel, the effective resistance becomes 20Ω. Calculate the ohmic value of the two resistors. (6 marks)

(d). Define the following terms
(i). Coulomb
(ii). Conductor

(iii). Insulator (6 marks)

3(a). Find the equivalent resistance for the circuit shown in figure.

(4 marks)

(b)(i). Find the capacitance to be connected in series with a 10μF capacitor for the equivalent capacitance to be 6μF. (3 marks)

(ii). A parallel plate capacitor has 19 interleaved plates each 75mm by 75mm separated by mica sheets 0.2mm thick. Assuming the relative permittivity of the mica is 5, Calculate the capacitance of the capacitor. (3 marks)

(c). Draw a well labeled diagram of a typical dry leclanche cell. (5 marks)

(d). Find the unknown currents marked in figure.

(5 marks)

4(a). (i). State the Maximum power transfer theorem. (3 marks)

(ii). A d.c source has an open circuit voltage of 30V and an internal resistance of 1.5 Ω. State the value of load resistance that gives maximum power dissipation and determine the value of this power. (4 marks)

(b). Determine, using Kirchoff's laws, each branch current for the network shown in figure Q4.

Q5(a). (i). What is a battery?

(ii). State the difference between a primary cell and a secondary cell. Give ONE example of each.

(iii). State the meaning of the following terms

i. Electrolysis

ii. Electroplating (12 marks)

(b). Ten 1.5V cells, each having an internal resistance of 0.2Ω, are connected in series to a load of 58Ω. Determine

i. The current flowing in the circuit

ii. The p.d at the battery terminals. (4 marks)

(c). In a lead-acid cell, state the colour of the positive plate and the negative plate when:

i. fully charged

ii. discharged (4 marks)

Q1(a). Find the equivalent resistance for the circuit shown in figure Q1(a) (4 marks)

Fig Q 1(a).

(b)(i). Draw the symbols for a fixed capacitor and a variable capacitor as used in electrical circuit diagrams. (3 marks)

(ii). Calculate the equivalent capacitance of two capacitors of 6μF and 4μF connected.

I. in parallel
II. in series (4 marks)

(c)(i). Draw a well labeled diagram of a typical dry Leclanche cell. (5 marks)

(ii). In a simple cell two faults exist. State and briefly explain each fault. (6 marks)

(iii). How can the effects of the two faults mentioned in question 1C (ii) above be minimized. (4 marks)

(d). A 300W electric bulb is connected to a 240V supply calculate.

(i). The current flowing in the bulb
(ii). The resistance of the bulb (4 marks)

2(a). Define the term "capacitance" and state the units in which it is measured. (2 marks)

(b). Capacitances of 3μF, 5μF and 6μF are connected in parallel to a direct voltage supply of 100V. Determine

(i). The equivalent circuit capacitance
(ii). The total charge.
(iii). The charge on each capacitor. (10 marks)

(c). What capacitance must be connected in series with a 30μF capacitor for the equivalent capacitance to be 12μF? (3 marks)

(d). List FIVE practical types of capacitors. (5 marks)

3(a). Distinguish between primary and Secondary cells, and give ONE example in each case. (6 marks)

(b). With the aid of a circuit diagram illustrate how FIVE 1.5V cells may be connected to power a load of 4.5V. (3 marks)

(c). EIGHT cells, each with an internal resistance of 0.2Ω and an e.m.f of 2.2V are connected.

(i). In series, (ii). In parallel. Determine the e.m.f and the internal resistance of the batteries so formed. (8 marks)

(d). State THREE typical applications of secondary cells. (3 marks)

4(i). State the SI units associated with the following electrical quantities.

(a). Electrical charge
(b). Conductance

(c). Electromotive force
(d). Potential difference
(e). Electrical Power (5 marks)

(ii). For the series-parallel network shown in figure Q4. Find
(a). The supply current
(b). The current flowing in each resistor
(c). The p.d across each resistor
(d). The Total power dissipated in the circuit
(e). The cost of energy if the circuit is connected for 80hrs. Assume electrical energy costs 14 cents per unit. (Kwh) (15 marks)

Fig Q4.

Q5(i). Define the following terms as used in electrical circuits

(a). Insulator
(b). Conductor
(c). Semi-conductor (6 marks)

(ii). State Kirchoff's current and voltage Laws. (4 marks)

(iii). Use Kirchoff's laws to determine the currents flowing in each branch of the network shown in figure Q5. (10 marks)

Fig. Q5