UNIVERSITY OF SWAZILAND
SUPPLEMENTARY EXAMINATIONS, JULY 2013

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER:	**BASIC ELECTRICAL ENGINEERING**
COURSE NUMBER:	**EE251**
TIME ALLOWED:	**THREE HOURS**

INSTRUCTIONS:

1. There are five questions in this paper. **Answer any FOUR questions.**
2. Each question carries 25 marks.
3. Marks for different sections are shown on the right hand margin.
4. Show the steps clearly in all your calculations including units of values calculated.
5. A sheet containing useful formulae is attached at the end of the question paper.

THIS PAPER IS NOT TO BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

THIS PAPER HAS SEVEN (7) PAGES INCLUDING THIS PAGE

QUESTION 1 ***(25 marks)***

(a) Two copper wires each of diameter 0.64 mm and length 1.2 m are used for connecting the positive and negative terminals of a 5V d.c. supply to an electronic circuit board which takes a current of 0.5 A. Calculate the supply voltage appearing across the electronic circuit board. You are given that the resistivity of copper is 1.7×10^{-8} Ω-m. *(8marks)*

(b) An Uninterruptible Power Supply (UPS) consists of a battery followed by an electronic converter circuit to generate the required output voltage from the battery voltage. Measurements show that the UPS can provide the required output power of 1 kW for only 15 mins. The electronic converter circuit looses 10% of its input power as heat.

(i) Calculate the W-h capacity of the battery. *(4 marks)*

(ii) Calculate the energy stored in the battery in Joules. *(3 marks)*

(c) Calculate the equivalent resistances R_1 and R_2 looking from either side (port) of the 6-resistor network shown in Fig.Q1c. *(10 marks)*

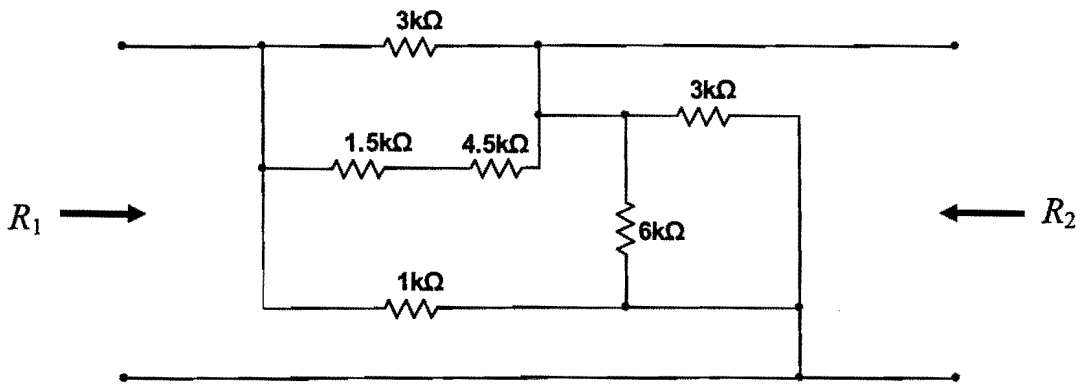

Fig. Q1c

QUESTION 2 *(25 marks)*

(a) Use **Delta-Star or Star-Delta** transformation to evaluate the current supplied by the battery in Fig.Q.2a. *(10 marks)*

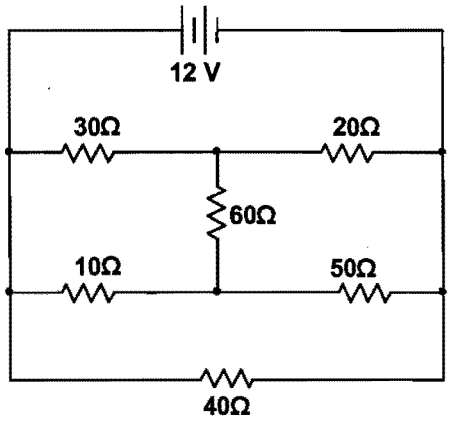

Fig. Q.2a

(b) Using the **mesh (loop) current** analysis method find the voltage across the current source shown in Fig.Q.2b. *(15 marks)*

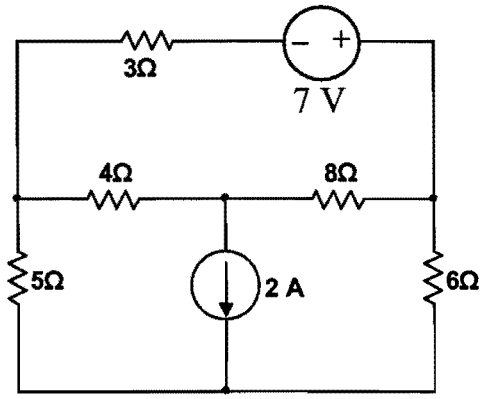

Fig. Q.2b

QUESTION 3 *(25 marks)*

(a) Consider the circuit shown in Fig. Q.3a.

(i) Find the Thevenin and Norton equivalents of the circuit across the points **a** and **b**. *(10 marks)*

(ii) If a variable resistor were connected between the points **a** and **b**, what would be the maximum power dissipated in the variable resistor? *(2 marks)*

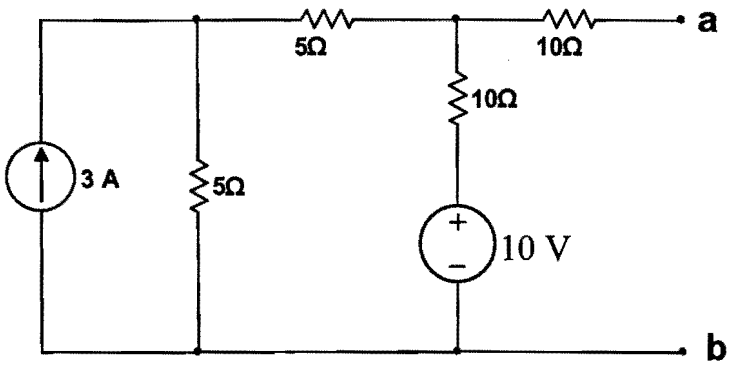

Fig. Q.3a

(b) Using the **superposition principle** calculate the voltage between the points **a** and **b** of the circuit in Q.3b. *(13 marks)*

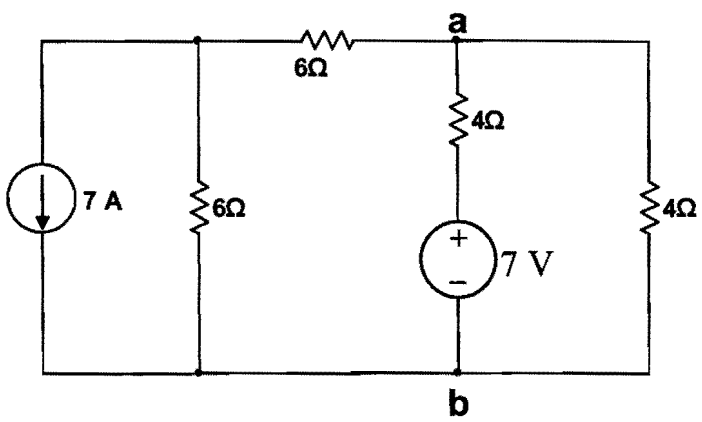

Fig. Q.3b

QUESTION 4 *(25 marks)*

(a) Use **nodal analysis** to find the node voltages V_a, V_b and V_c shown in Fig.Q.4a. *(12 marks)*

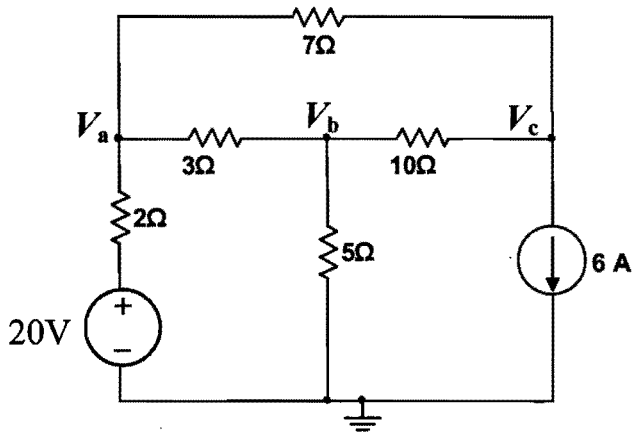

Fig. Q.4a

(b) A 40-μF capacitor is initially charged to an unknown voltage, V_o. At time t = 0, a resistor of 2 kΩ is switched to discharge the capacitor. After 50 ms the voltage across the capacitor reduces to 20 V. What was the initial voltage V_o across the capacitor? *(5 marks)*

(c) A series RLC circuit is connected to a variable frequency supply which has a constant voltage 30 V. If $R = 2.5\ \Omega$, $L = 47$ mH and $C = 22$ nF, determine:

(i) the resonance frequency of the circuit. *(2 marks)*

(ii) the current in the circuit at resonance. *(2 marks)*

(iii) the voltages across the inductance, at resonance, and *(2 marks)*

(iv) Compare your answer to (iii) with the supply voltage and comment *(2 marks)*

QUESTION 5 ***(25 marks)***

(a) The voltage and current waveforms for a circuit are given by

$$v(t) = 90\cos(300t - 15°) \quad \text{and} \quad i(t) = \sin(300t - 60°)$$

If it is known that the circuit consists of two RLC elements in series, use phasors to find the actual values of these elements. *(10 marks)*

(b) For the a.c. circuit shown in Fig.Q5b, determine:

(i) The total impedance of the circuit, *(6 marks)*

(ii) The power factor of the combined circuit stating whether it is leading or lagging. *(3 marks)*

(iii) The total Active Power taken from the supply, *(2 marks)*

(iv) The total Reactive Power supplied, *(2 marks)*

(v) The Apparent Power supplied. *(2 marks)*

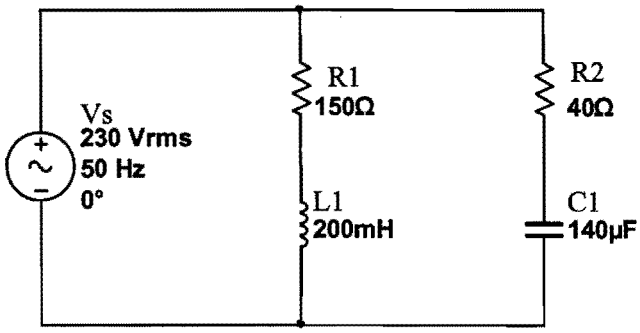

Fig. Q5b

========= *end of exam paper, attachment follows* ==========

SOME SELECTED FORMULAE

$$R = \rho \frac{l}{a}$$

$$P = V_{rms} I_{rms} \cos\phi, \qquad V_{rms} = \frac{V_m}{\sqrt{2}}, \qquad P^2 = Q^2 + R^2$$

$$Z = \frac{\vec{V}}{\vec{I}} = R + jX$$

$$R = \frac{V_R}{I_R}, \qquad X_L = \left|\frac{V_L}{I_L}\right| = \omega L, \qquad X_C = \left|\frac{V_C}{I_C}\right| = \frac{1}{\omega C}$$

$$W_L = \frac{1}{2} L I^2 \qquad W_C = \frac{1}{2} C V^2$$

$$\omega_0^2 LC = 1, \qquad Q = \omega_0 L / R$$

$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C}, \qquad R_A = \frac{R_1 R_2 + R_2 R_3 + R_1 R_3}{R_1}$$

$$v_C(t) = V_s \left(1 - e^{-t/RC}\right), \qquad v_C(t) = V_i e^{-t/RC}$$