UNIVERSITY OF SWAZILAND
SUPPLEMENTARY EXAMINATION, JULY 2012

FACULTY OF SCIENCE

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 any assumptions made.

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

THIS PAPER HAS SEVEN (6) PAGES INCLUDING THIS PAGE

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

(a) On a typical Saturday, from midnight Friday to midnight Saturday, a home uses a 400-W washing machine for 3 hrs, a 1800-W ironing box for 2 hrs, a 150-W TV for 8 hrs, a 100-W audio system for 4 hrs, ten 60-W light bulbs for 4 hrs, 2000W cooker for 4 hrs, and a 150-W fridge which is off for a total of 7 hrs during this period. Find the following:

(i) The total cost of electricity used in this home on this Saturday, given that the service company (SEC) charges E0.84 per unit (kWh).

(7 mark)

(ii) The input current to the home if all these appliances are switched on simultaneously and the overall power factor is 0.9 lagging. *(3 marks)*

(b) Consider the circuit shown in Fig. Q.1.b.

Given that $I_2 = 2.5$ A and $I_3 = 1.5$ A, find the values of R_2 and R_3. *(6 marks)*

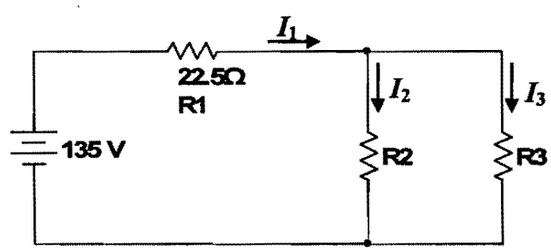

Fig. Q1.b

(c) In Fig. Q.1c, find the current and power dissipation in resistor R_8. *(9 marks)*

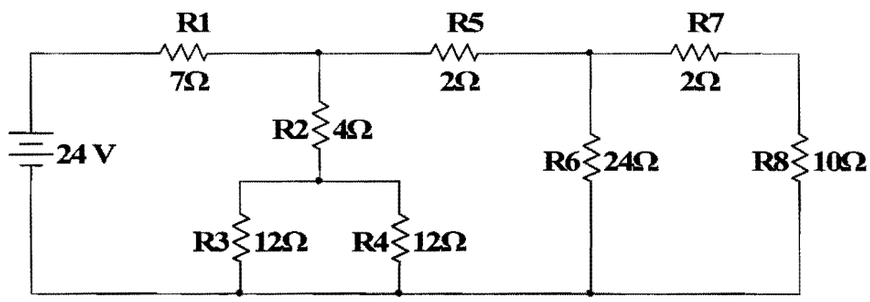

Fig.Q1.c

QUESTION 2 ***(25 marks)***

(a) By using mesh analysis in the circuit shown in Fig. Q.2a, find the power dissipation in the resistor R_3. *(14 marks)*

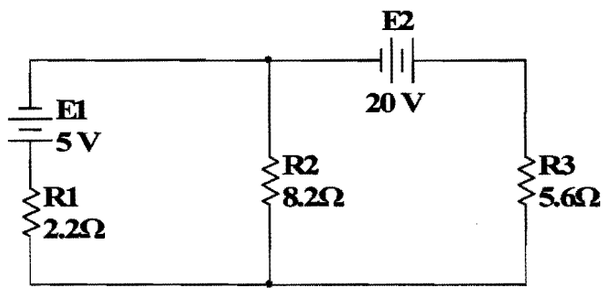

Fig.Q.2a

(b) By applying the superposition theorem in the circuit shown in Fig. Q.2b, find the magnitude and direction of the current through resistor R_5. *(11 marks)*

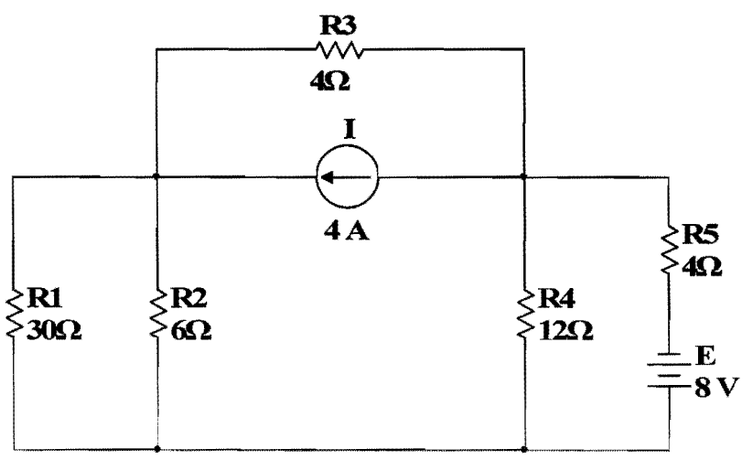

Fig.Q.2b

QUESTION 3 ***(25 marks)***

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

(i) Find the Thevenin equivalent of the circuit across the points A and B. *(9 marks)*

(ii) If a variable resistor were connected across the points A and B, what maximum power would it draw from the circuit? *(3marks)*

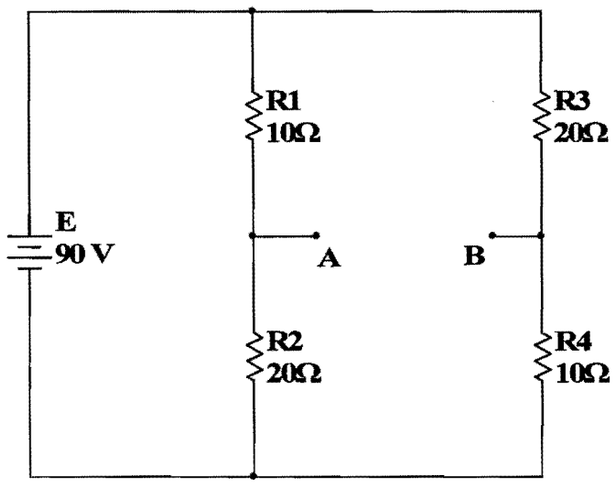

Fig. Q.3a

(b) A coil of 300 turns is wound uniformly over a wooden ring (non-magnetic) having a mean circumference (length of magnetic path) of 700 mm and uniform cross-section 600 mm^2.

A current of 5 A is passed through the coil. The permeability of free air = $4\pi \times 10^{-7}$ H/m.

(i) Calculate the magnetic field strength in the coil. *(3 marks)*

(ii) Determine the flux density in the coil. *(3 marks)*

(iii) Find the total flux in the coil. *(3 marks)*

(iv) If the wooden ring is replaced with a steel ring of the same size and shape and the same number of turns wound on it how would your answers to (i), (ii) and (iii) change? *(4 marks)*

QUESTION 4 ***(25 marks)***

(a) A 10-μF capacitor connected in series with a 500-kΩ resistor is switched across a 50-V dc battery at time $t = 0$ s.

(i) Calculate the time constant of the circuit. *(2 marks)*

(ii) Determine the equation for the voltage across the capacitor as a function of time.

(6 marks)

(iii) Find the voltage across the capacitor, 7 seconds after switching on. *(3 marks)*

(iv) Determine the time at which the voltage across the capacitor reaches 45 V.

(4 marks)

(b) For the circuit shown in Fig. Q.4b, find the equivalent impedance Z_T looking into the circuit. *(10 marks)*

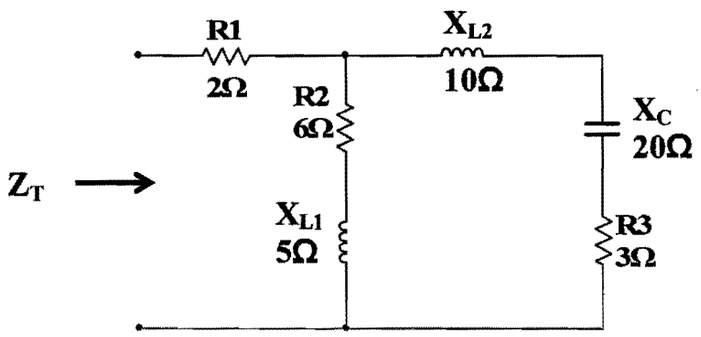

Fig. Q.4b

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

(a) A series circuit consisting of an inductor 159 μH, a resistor 1.1 Ω and a capacitor, is connected to a 100-mV sinusoidal a.c. supply of frequency 10 kHz.

(i) Find the value of the capacitor which will result in resonance of the circuit. *(4 marks)*

(ii) Determine the Q of the circuit. *(3 marks)*

(iii) What is the bandwidth of the circuit? *(3 marks)*

(iv) What are the lower and upper cutoff frequencies? *(2 marks)*

(b) The instantaneous voltage and current in an a.c. circuit are given by

$$v(t) = 300\cos(314t + 30^\circ) \quad \text{volts}$$

$$i(t) = 30\cos(314t - 30^\circ) \quad \text{amps}$$

(i) Sketch the voltage and current waveforms on the same axes. *(3 marks)*

(ii) Is the circuit inductive or capacitive? Explain your answer. *(1 mark)*

(iii) Calculate the following:

the instantaneous power,

the real power,

the reactive power,

the apparent power,

absorbed by the circuit. *(9 marks)*

========= *end of exam paper* =========