UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

FIRST SEMESTER EXAMINATION 2011/12

TILE OF THE PAPER: **BASIC ELECTRICAL ENGINEERING**
COURSE CODE: **EE251**
TIME ALLOWED: **THREE** HOURS

INSTRUCTIONS TO CANDIDATES

1. Answer any **FOUR (4)** questions only.
2. Each question carries 25 marks.
3. Show the steps clearly in all your calculations.
4. State clearly any assumption made.

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

This paper contains EIGHT (8) pages including this page

QUESTION 1

(a) Suppose you have seen the readings of 300 kWh at 6 am in a day in your house's pre-paid energy meter connected to the single-phase supply of 230-V supplied by Swaziland Electricity Company (SEC). Between 6 am and 6 pm in the same day you have used the following appliances

- 120-W Freezer with total off-time of 1 hour during the period
- 1500-W electric oven for 3 hours
- 1200-W electric heater for 5 hours
- 450-W washing machine for 1 hour
- Three tube lights each of 60-W for 2 hours each

Find the following:

(i) Expected reading of the pre-paid meter at 6 pm in the same day. **[4 marks]**

(ii) The input current from the supply if all the appliances are operated simultaneously when overall power factor is 0.85 (lag). **[2 marks]**

(iii) Efficiency of your electrical wiring systems of your house if you find that the actual energy consumption during that period is 0.4 kWh more than that of your expectation. **[2 marks]**

(b) For the series-parallel network of the Fig. Q1b, find the following

(i) The current I_s **[6 marks]**

(ii) Find the currents I_2 and I_8 **[2 marks]**

(iii) Find the current I_7 **[3 marks]**

(iv) Find the voltage V_{ab} **[3 marks]**

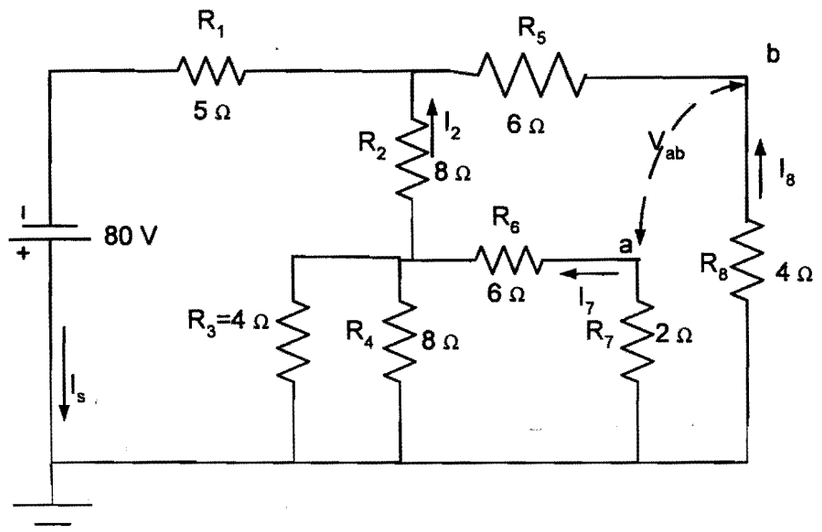

Fig.Q1b

(c) With appropriate diagrams explain the meaning of short and open circuits. **[3 marks]**

QUESTION 2

(a) Find the voltage V_s across R_5 as shown in Fig.Q2a through applying superposition theorem.

[15 marks]

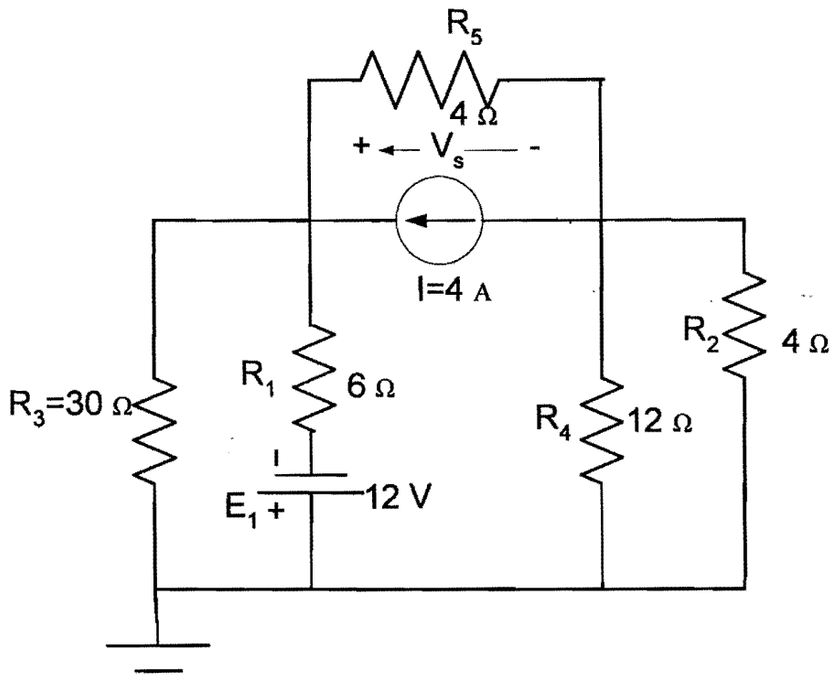

Fig.Q2a

(b) Apply mesh analysis to find the mesh currents for the circuit shown in Fig.Q2b. Hence, determine the power dissipated in resistor R_2. **[10 marks]**

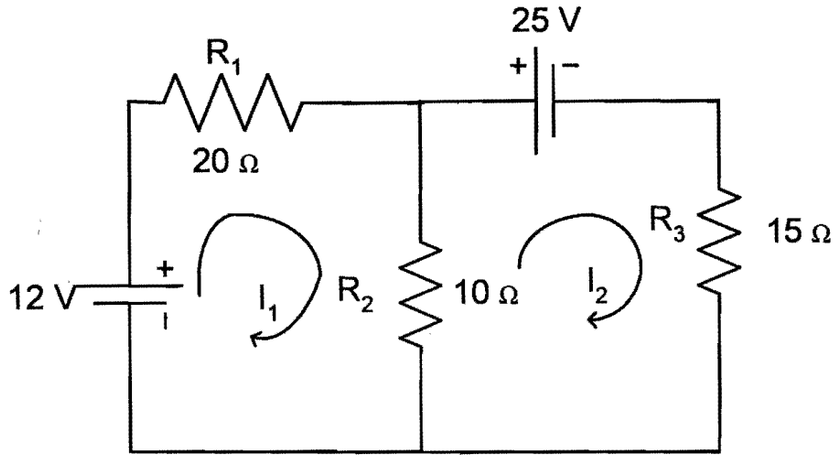

Fig.Q2b

QUESTION 3

(a) Using the supernode approach, determine the nodal voltages for the networks of Fig. Q3a below and hence find the current through the DC source of 16V.

[11 marks]

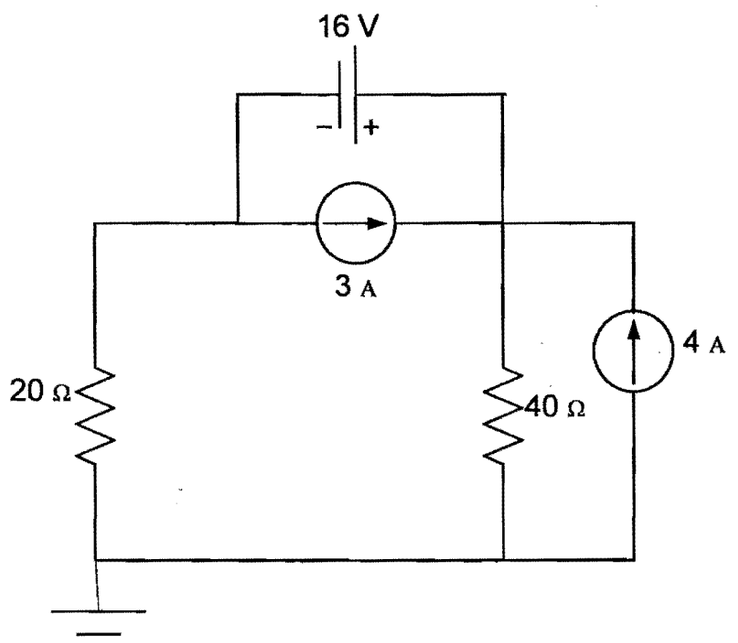

Fig. Q3a

(b) Find the Thévenin equivalent circuit for the network at the terminals of R_L of the bridge network of Fig. Q3b below. If maximum power is to be transferred to R_L what would be its resistance and how much maximum power will be dissipated by R_L?

[10+4 marks]

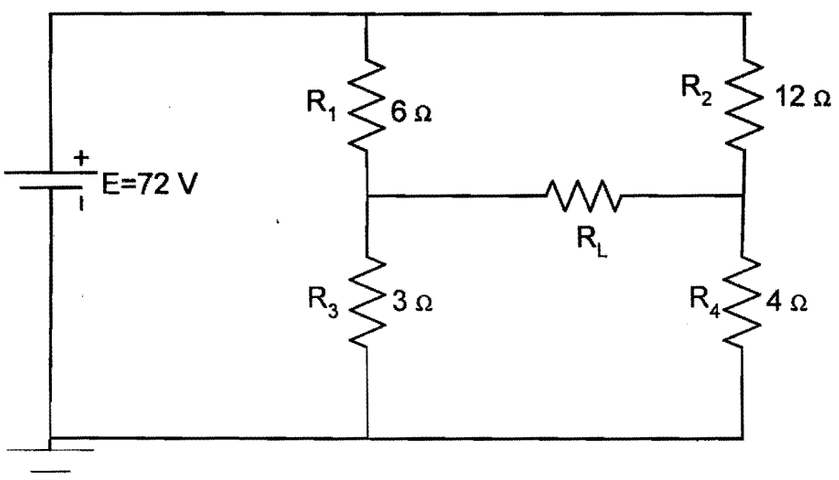

Fig. Q3b

QUESTION 4

(a) Given that in the magnetic circuit shown in Fig.Q4a, area (throughout)=2×10^{-4} m^2, $l_{ab}=l_{ef}=0.05$ m, $l_{af}=l_{be}=0{,}02$ m, $l_{bc}=l_{de}$. B-H curve of sheet steel is given in page 8. For air gap $H_g=(7.96\times10^5)\,B_g$ At/m

(i) Find the current I necessary to establish a flux of $\Phi=2.4\times10^{-4}$ Wb. **[7 marks]**

(ii). Compare the mmf drop across the air gap to that across the rest of the magnetic circuit. Discuss your results using the value of μ for each material. **[4 marks]**

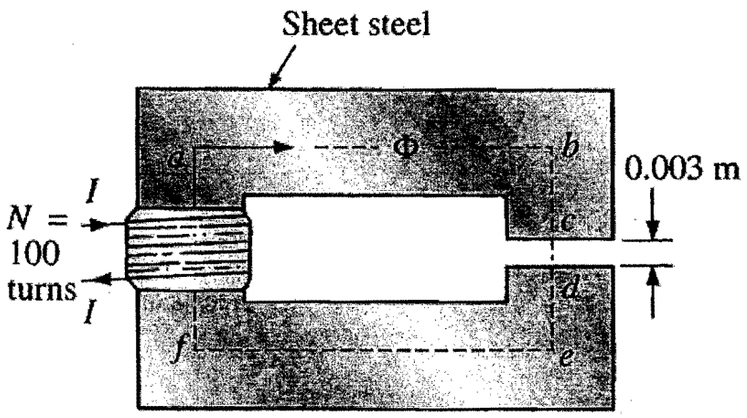

Fig.Q4a

(b) For the circuit shown in Fig.Q4b

(i) Determine the time constant of the circuit . **[2 marks]**

(ii) Write the mathematical equation for the voltage v_C following the closing of the switch. **[2 marks]**

(iii) Determine the voltage v_C after one and five time constants. **[2 marks]**

(iv) Write the equations for current i_C and voltage v_R. **[3 marks]**

(v) Determine the time at which the voltage across the capacitor will be 15 V **[2 marks]**

(vi) Sketch the waveforms for v_C and i_C. **[3 marks]**

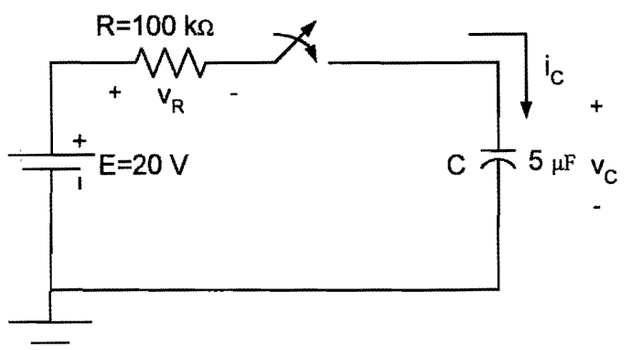

Fig.Q4b

QUESTION 5

(a) Fig. Q5a below shows the waveform displayed on the screen of a oscilloscope. Note that oscilloscope's vertical sensitivity is 10 mV/div and horizontal sensitivity is 10μs/div. For this waveform,

(i) Determine the period. **[2 marks]**
(ii) Find the frequency. **[2 mark]**
(iii) Determine the average value. **[4 marks]**
(iv) Determine the rms value. **[4 marks]**

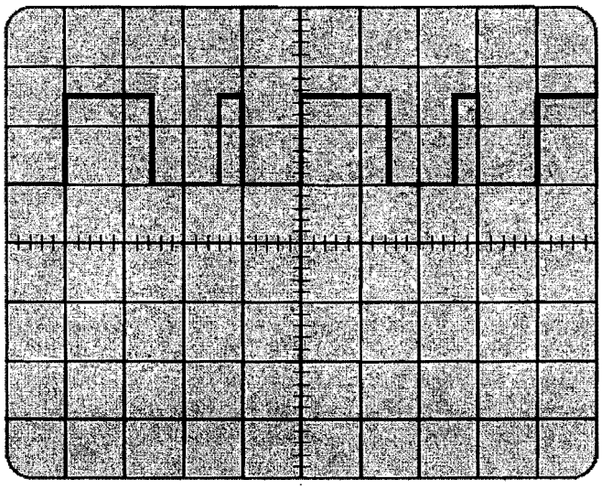

Fig. Q5a

(b) For the circuit shown in Fig.Q5b (next page)

(i) Determine the magnitude of the current I at resonance. **[1 marks]**
(ii) Find the voltages V_R, V_L, and V_C at resonance, and compare their magnitudes. **[4 marks]**
(iii) Determine the quality factor of the circuit. Is it a high or low-Q circuit? **[2 marks]**
(iv) If the resonant frequency is 5 kHz, determine the value of L and C. **[3 marks]**
(v) Find the bandwidth of the response if the resonant frequency is 5 kHz. **[1 marks]**
(vi) What are the low and high cutoff frequencies? **[2 marks]**

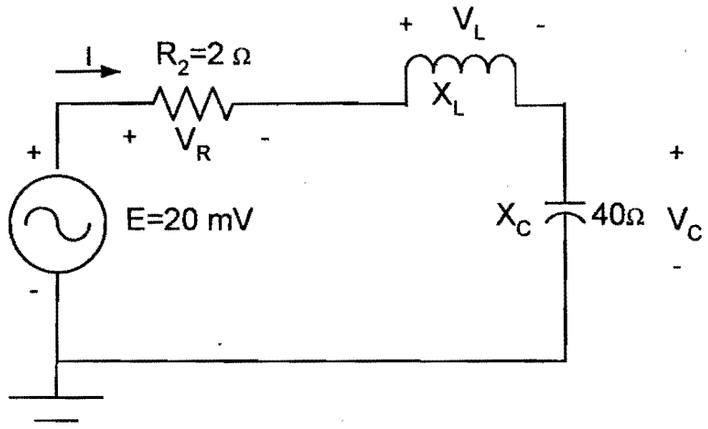

Fig.Q5b

QUESTION 6

(a) Given that $v(t)=120\cos(314t+45^0)$V and $i(t)=10\cos(314t-10^0)$A at the terminals of a passive linear network,

(i) Draw the voltage and current waveforms. **[2 marks]**

(ii) Mention the types of the network and give reason of your answer. **[2 mark]**

(iii) Find the instantaneous power, the average power, reactive power and apparent powers absorbed by the network. **[4 marks]**

(b) For the network shown in Fig. Q6b

(i) Find $\mathbf{Z_T}$ and $\mathbf{Y_T}$. **[4 marks]**

(ii) Find currents $\mathbf{I_1}$ and $\mathbf{I_2}$, $\mathbf{I_3}$ and $\mathbf{I}$. **[2x4=8 marks]**

(iii) Verify Kirchhoff's current law by showing that $\mathbf{I = I_1 + I_2 + I_3}$. **[2 marks]**

(iv) Use complex conjugate method to calculate power and hence draw the power triangle. **[3 marks]**

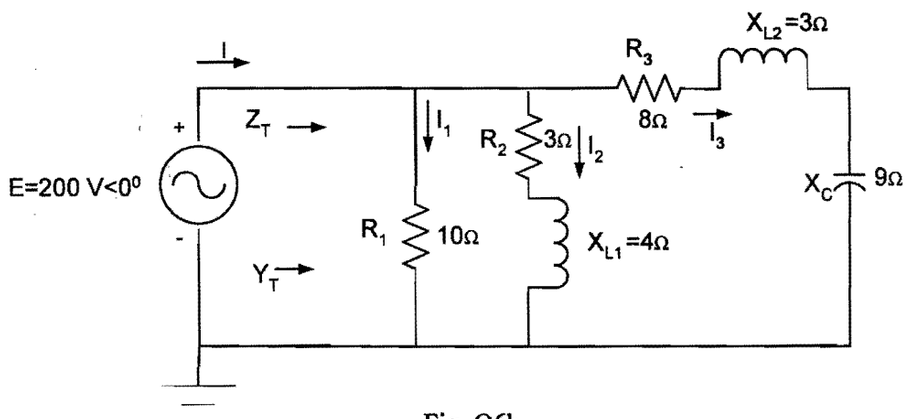

Fig. Q6b

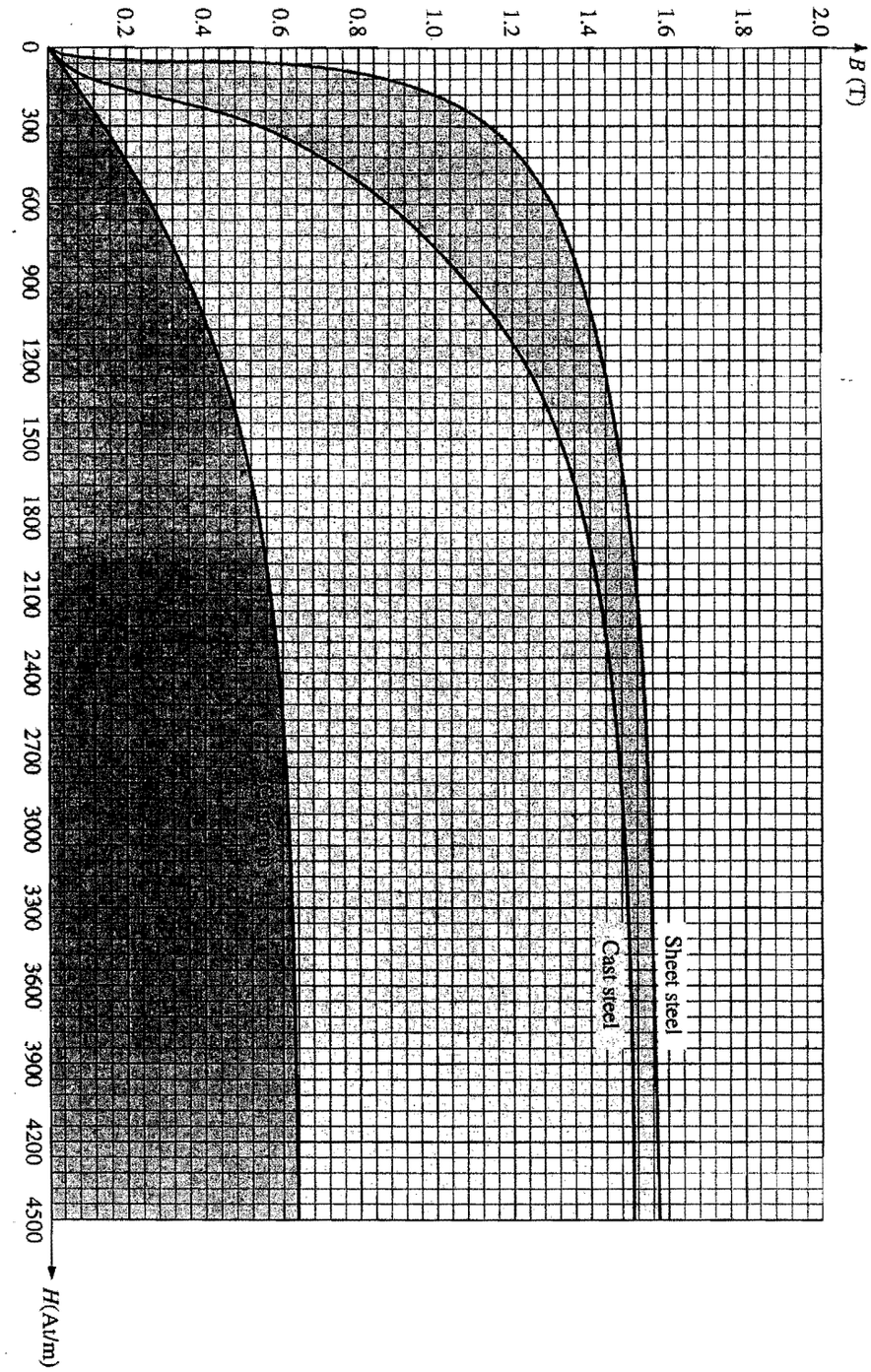

Fig. B-H curve needed for Q 4(a)

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