UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

MAIN EXAMINATION

DECEMBER 2017

TITLE OF PAPER: BASIC ELECTRICAL ENGINEERING

COURSE CODE: EE251/EEE251

DURATION: 3 HOURS

INSTRUCTIONS:

1. There are five (5) questions in this paper. Answer question 1 and any other three (3) questions.
2. Each question carries equal marks.
3. Start each question in a new page.

This paper should not be opened until permission has been given by the invigilator.

This paper contains six (6) pages including this page.

Question 1 [25 Marks]

a. A graph of a car battery rated at 70Ah and current drain of 5A is shown in Figure Q.1a.

i. How long will the battery supply 20A of current? [3 Marks]

ii. If the rating of the battery is not allowed to go below 64Ah, for how long can the battery supply the rated current? [3 Marks]

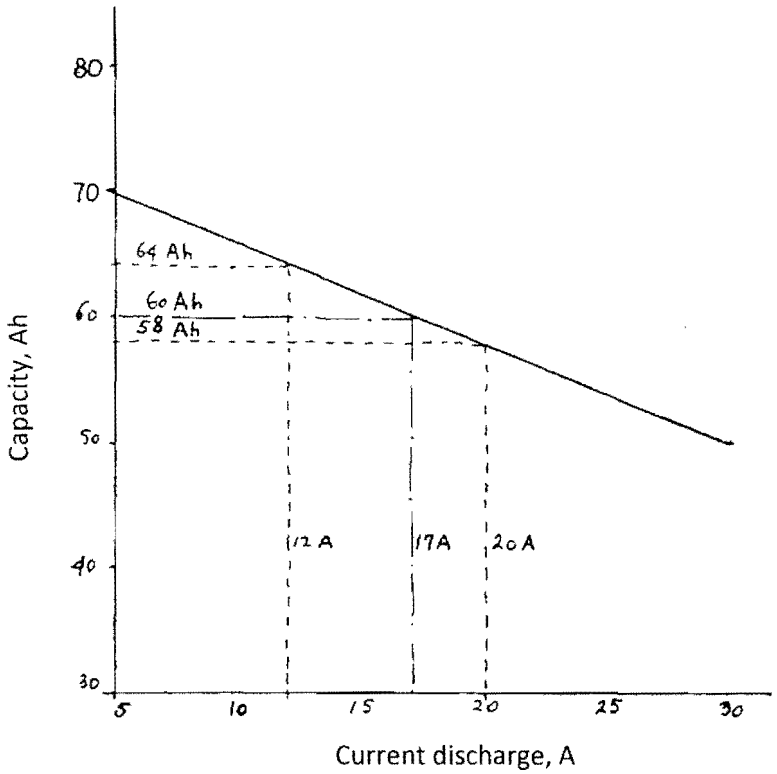

Figure Q.1a

b. The minimum current required for the operation of a relay coil is 500mA at 120V, if the current taken by the coil at 20^0C is 530mA (at 120V) and the temperature coefficient of the resistor material is 0.00427^0C^{-1} at 00C, calculate the maximum temperature above which the relay will fail to operate [6 Marks]

c. A wire of uniform cross section has a resistance of 0.8Ω. If the length of the wire is doubled and its cross sectional area increased 4 times, what is the resistance? (Ignore the effect of temperature). [3 Marks]

d. Normally, heat energy is measured in joules (J). Given that you are required to design a heating element to boil a certain amount of water in 2 minutes using 200 kilojoules of energy. If the heating element is to operate at 240V, calculate its current and power rating. [4 Marks]

e. What is the total cost of using the following appliances at 1 Lilangeni 34 cents per kilowatt-hour?

i.	100W home theatre system for 2 hours.	[1 Mark]
ii.	150 W LCD TV for 3hrs 20 minutes	[1 Mark]
iii.	1500 W electric heater for 30 minutes	[1 Mark]

f. Determine the ratio of powers dissipated in two resistors, each having the same length and each made of copper wire of circular cross section, but one having a diameter twice that of the other, and each being connected across the same voltage.

[3 Marks]

Question 2 [25 Marks]

a. Reduce the resistor network between terminals a and b of Figure Q.2a to a single resistor. [3 Marks]

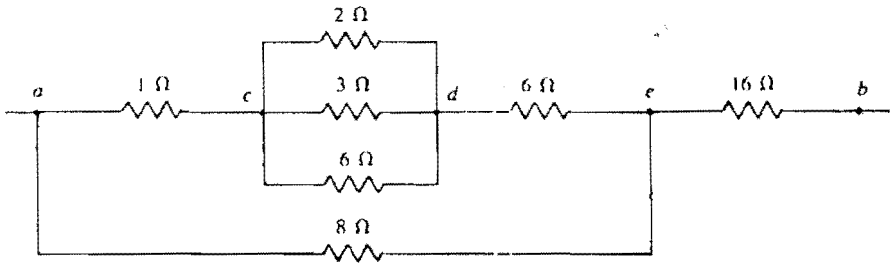

Figure Q.2a

b. In Figure Q.2a, use wye-delta or delta-wye transformation to evaluate the following;

i. The current supplied by the source, i.e. I_s. [6 Marks]

ii. The voltage across R_4. [2 Marks]

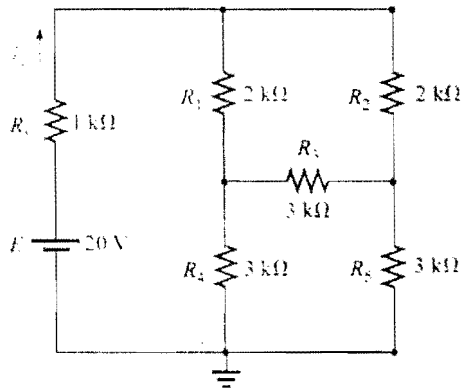

Figure Q.2a.

c. In Figure Q.2b, use the mesh current analysis technique to find;

i. The loop and branch currents. [10 Marks]

ii. The power supplied by the 100V and 50V sources. [4 Marks]

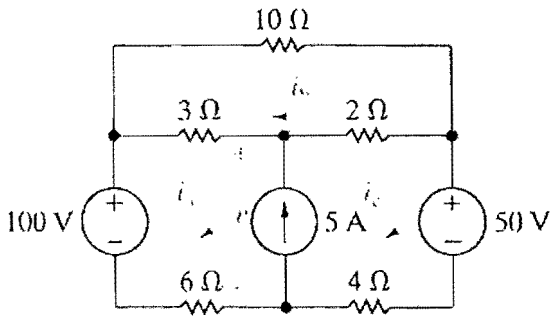

Figure Q.2b.

Question 3 [25 Marks]

a. Find the maximum power transferred to R in the circuit of Figure Q.3a.

[10 Marks]

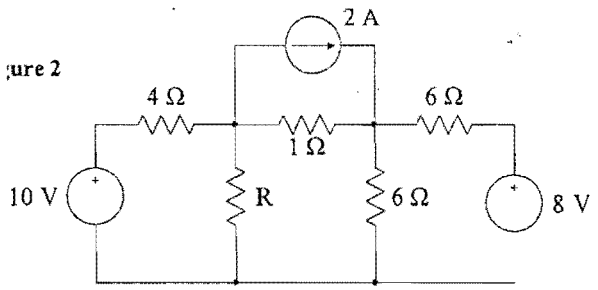

Figure Q.3a.

b. Use transformations and nodal analysis to find current I_1 and I_2 in the circuit shown in Figure Q.3b.

[10 Marks]

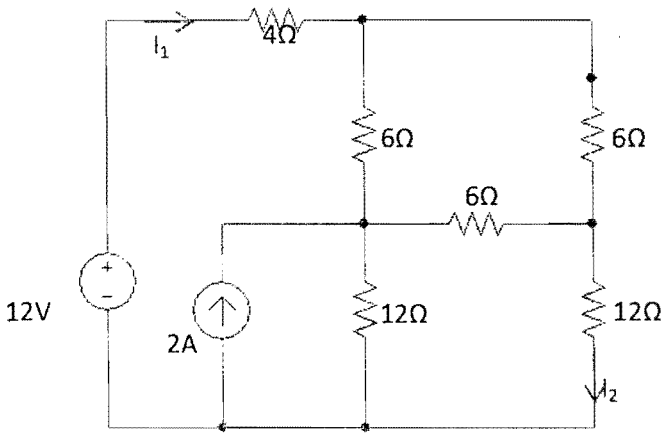

Figure Q.3b.

c. Consider the circuit of Figure Q.3c to answer the following.

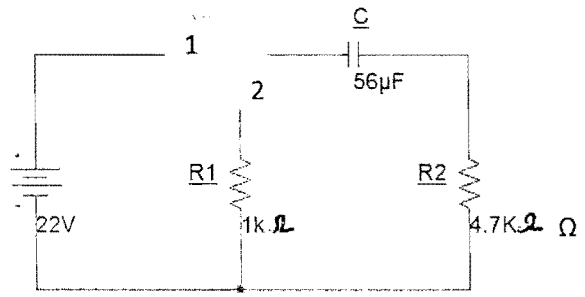

Figure Q.3c

i. Determine the time it takes for the capacitor to fully charge. [1 Mark]

ii. Give the mathematical expression for v_c and i_c when the switch is at position 1. [2 Marks]

iii. Sketch the transients for v_c and i_c when the capacitor is charging.

[2 Marks]

Question 4 [25 Marks]

a. Given the circuit of figure Q.4a,

i. Find the displacement current "through" each capacitor at time (t=0).

[7]

ii. Find the voltage across each capacitor under steady state conditions (i.e. the capacitors have been charging for a long time).

[7]

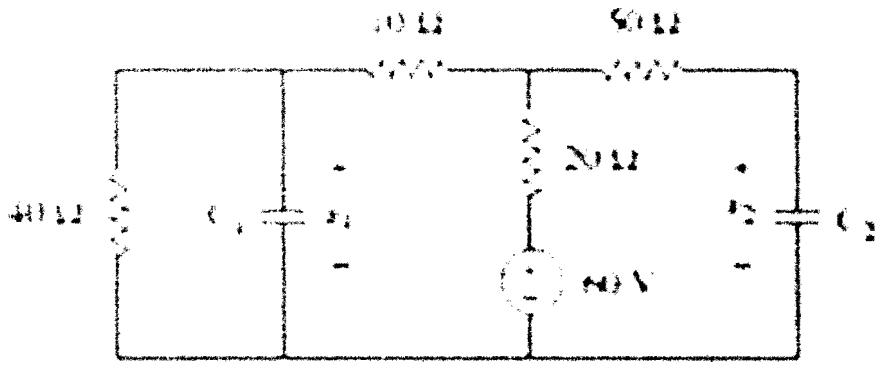

Figure Q.4a.

b. Given the circuit of figure Q.4b,

i. Find the expression of i_0 when the inductor is discharging. Assume it has been charging for a long time.

[7]

ii. Sketch the waveform of i_0.

[4]

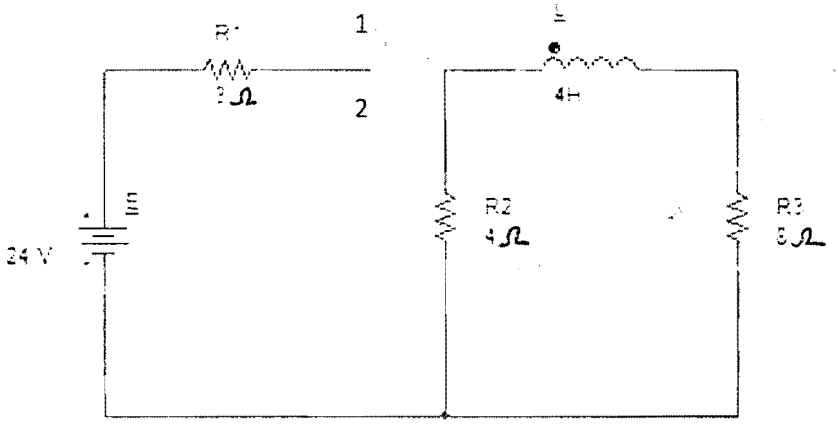

Figure Q.4b.

Question 5 [25 Marks]

a. Given the circuit shown in Figure Q.5a, answer the following:

i. Use mesh analysis to determine current I_1 and I_2 [16 Marks]

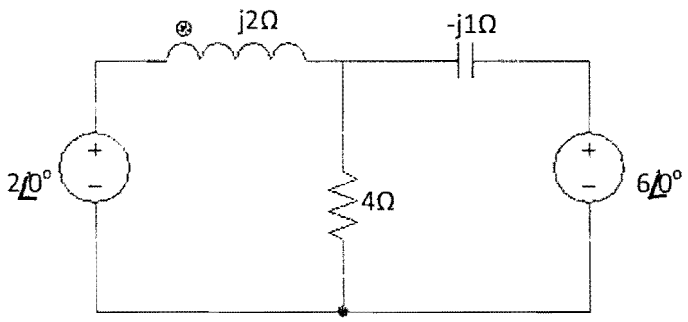

Figure Q.5a

ii. Find the power supplied (or absorbed) by each source of the circuit. [4 Marks]

b. An impedance $Z_1 = (4 + j4)\Omega$ is connected in parallel with an impedance $Z_2 = (12 + j6)\Omega$. If the input reactive power is 2500VAR (lagging), what is the total active power? [5 Marks]

End of Paper