UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

MAIN EXAMINATION

DECEMBER 2016

TITLE OF PAPER: BASIC ELECTRICAL ENGINEERING

COURSE CODE: EEE251/EE251

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. Describe a rheostat and potentiometer. Give two examples where they can be used. [2 Marks]

b. Using simple circuit diagrams illustrate how each can be connected in a circuit. [4 Marks]

c. An experimenter building the voltage circuits shown in Figure Q.1c predicted that varying the resistance **R2** and **R3** should give the results shown on the graphs below the circuits.

i. Make pairs of each voltage divider circuit (a) or (b) with a corresponding graph (c) or (d). Give reasons for your pairs. Further determine what the axis variables **X** and **Y** should be. [6 Marks]

ii. Define the labeling of the graphs by working out, from the circuit variables, expressions for the voltages labelled **A**, **B**, **C**, **D** and **E**.. [10 Marks]

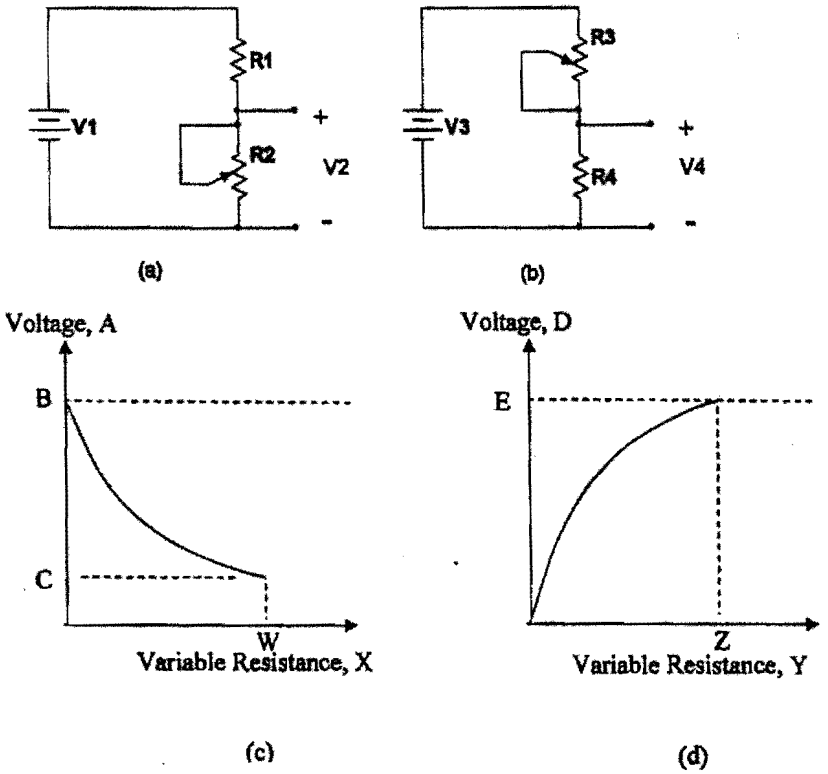

Figure Q.1c.

d. 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. 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. [7 Marks]

ii. The Voltage across R_4. [3 Marks]

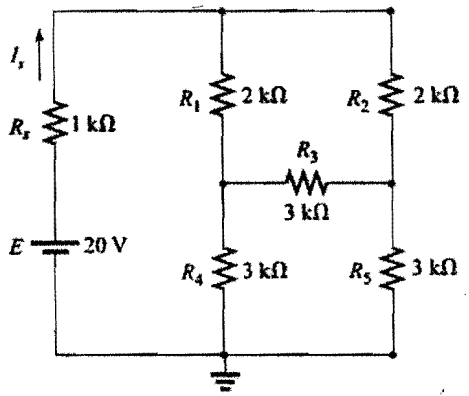

Figure Q.2a.

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

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

ii. The voltage across 1 Ω and 4 Ω resistor. [5 Marks]

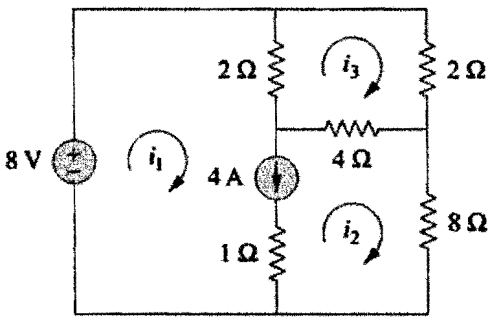

Figure Q.2b.

Question 3 [25 Marks]

a. Consider the circuit shown in Figure Q.3a.

i. Find the Thevenin equivalent of the circuit across the points **a** and **b**. [7 Marks]

ii. If a variable resistor were connected between the points **a** and **b**, what will be the maximum power dissipated in the variable resistor? [2 Marks]

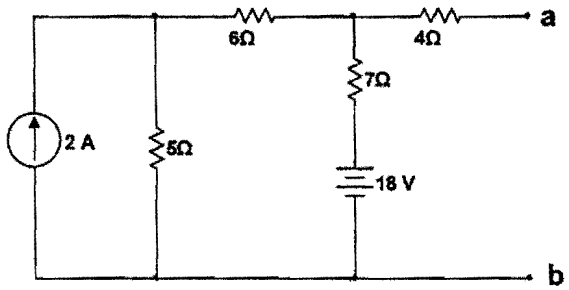

Figure Q.3a.

b. Use nodal analysis to find the voltage through the 4 Ω resistor shown in Figure Q.3b. [7 Marks]

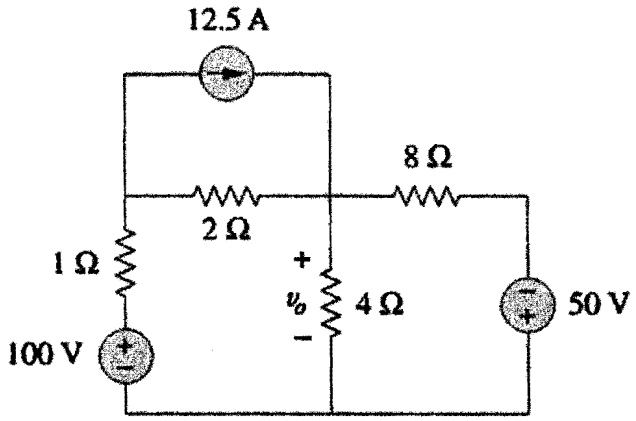

Figure Q.3b.

c. The circuit shown in Figure Q.3c has two current sources one of which is a voltage dependent source. Find the following:

i. The voltage across the independent current source. [5 Marks]

ii. The power dissipated in each resistor. [2 Marks]

iii. The total power supplied by the sources. [2 Marks]

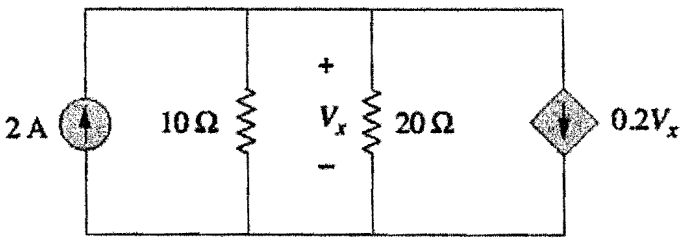

Figure Q.3c.

Question 4 [25 Marks]

a. A 4 Ω resistor in series with a 7.96 mH inductor is connected across a 230 V 50 Hz source. Determine:

i. The total impedance. [2 Marks]
ii. The input current [2 Marks]
iii. The voltages across the resistor and the inductor. [3 Marks]
iv. Draw a phasor diagram showing the current and the voltages. [4 Marks]
v. The power factor. [2 Marks]
vi. The input power. [2 Marks]

b. Given that an inductor draws 5 A of current at 230 V 50 Hz, find the inductive reactance and the inductance. [4 Marks]

c. Given that a capacitor draws 2 A of current at 230 V 50 Hz. Find the capacitive reactance and the capacitance. [4 Marks]

Question 5. [25 Marks]

a. A circuit consisting of a coil of inductance 150 μH and resistance 5 Ω, in series with a capacitance of 22 nF is connected to a variable frequency supply which has a constant voltage 20 V. 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 and the capacitor at resonance. [3 Marks]
iv. The Q-factor of the circuit [2 Marks]

b. A coil of inductance 0.1 H is connected across a 50 V, 60 Hz supply, in parallel with it is a 60 μF capacitor which is also in parallel with a 30 Ω resistor as shown in Figure Q.5b. Determine:

i. The total impedance of the circuit. [4 Marks]
ii. The branch currents [3 Marks]
iii. The total Active Power taken from the supply. [2 Marks]
iv. The total reactive power supplied. [3 Marks]
v. The apparent power supplied. [2 Marks]
vi. The power factor of the combined circuits stating whether it is leading or lagging. [2 Marks]

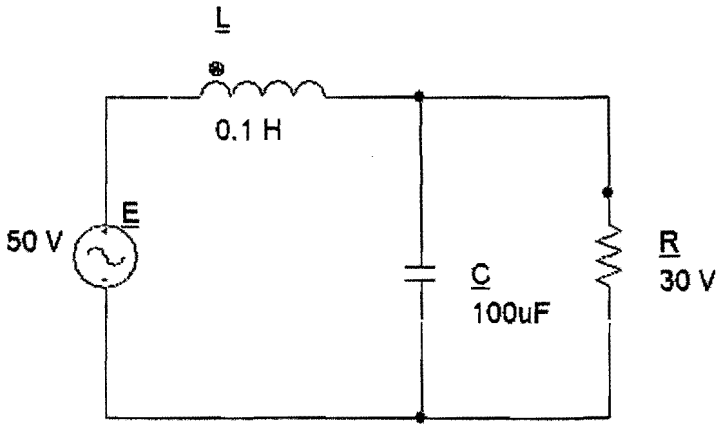

Figure Q.5b.

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