SOUTH EASTERN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING

END SEMESTER EXAMINATION – JULY 2019
SEMESTER I - 2017 / 2018

EE 13001 - PRINCIPLES OF ELECTRICAL ENGINEERING
Time Allowed: Three hours

Answer all six questions. All questions carry equal marks.

Instructions:
Answer Section A and Section B **separately** and answer script will be **collected separately**.

Please **do not** tie Section A and B together.

Section A

1) Consider the circuit shown in Figure Q1. All voltages are given with respect to the ground (0V).

a) Find the voltage across the 4Ω resistor V_X and hence calculate the current through it, $I_{(4)}$. *(20 marks)*

b) Also find I_S by applying KCL to node B. *(30 marks)*

c) Apply KCL to node A and find I_1. *(30 marks)*

d) Calculate the power in all the resistors. *(12 marks)*

e) What is the power associated with the I_1 source? *(06 marks)*

f) Indicate whether it is 'provided' or 'absorbed' by the I_1 source. *(02 marks)*

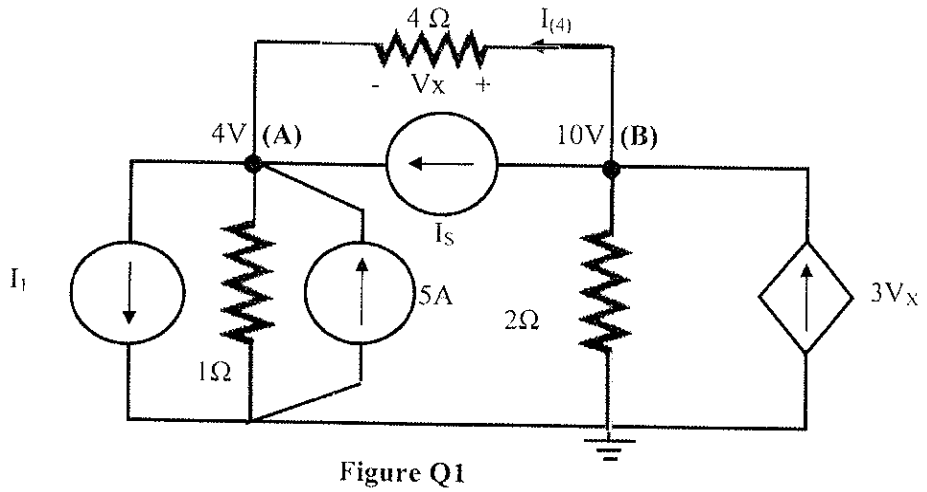

Figure Q1

2) Consider the circuit shown in Figure Q2.

a) Simplify the circuit by combining resistors where possible. *(10 marks)*

b) Apply KVL to find the current through the 30 Ω resistor. *(30 marks)*

c) Find the power absorbed by the 30 Ω resistor. *(20 marks)*

d) What is the power associated with the dependent source? *(20 marks)*

e) Calculate the current through the 10 Ω resistor. *(20 marks)*

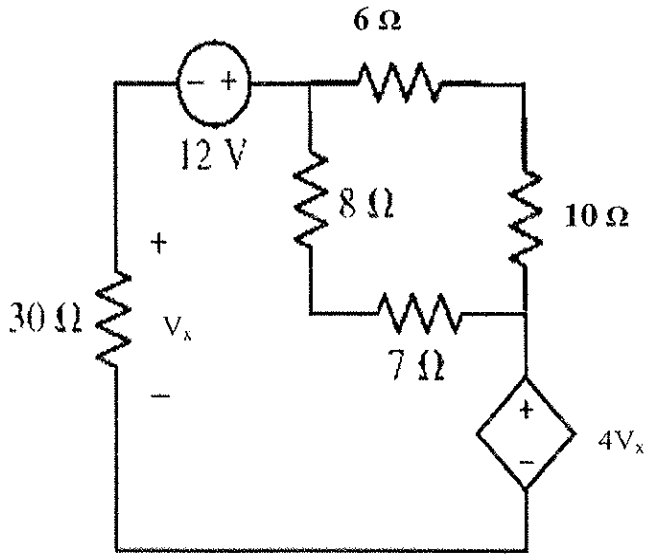

Figure Q2

3) a) Consider the circuit shown in Figure Q3a.

i) Find the Thevenin equivalent of the circuit connected to R_L. *(40 marks)*

ii) What value of R_L would absorb maximum power from the circuit? *(10 marks)*

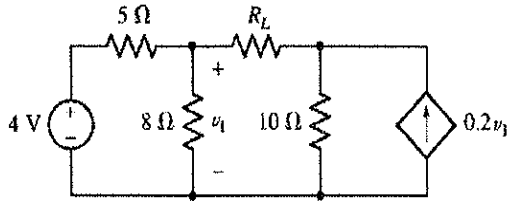

Figure Q3a

b)

i) A resistance R and a 5 μF capacitor are connected in series with a switch, across a 200 V d.c. supply. Calculate the value of R that will make the capacitor voltage reach 100 V, 5 seconds after the switch has been closed. (20 marks)

ii) What will be the current through the resistor R, 10s after closing the switch?

(30 marks)

Section B

4) i) Mathematically prove the inductive impedance and the capacitive impedance, while explaining their corresponding phase angles. *(20 marks)*

ii) A given RL series circuit, a voltage of 7.9 V at 48.86 Hz produces a current of 568.45 mA while the same voltage at 68.45 Hz produces 456.89 mA. What are the values of R and L in the circuit? *(20 marks)*

iii) A 65.286 Hz sinusoidal voltage $v = (156.75)\sin(ft)$ is applied to a series RL connection. The values of the resistance and the inductance are 8.9 ohms and 0.0256 H respectively. (Strictly state your assumptions.) *(30 marks)*

a) Calculate the r.m.s value of the current in the circuit and its phase angle with respect to the voltage.

b) What is the expression for the instantaneous current in the circuit.

c) Find the r.m.s value and the phase of the voltages appearing across the resistance and the inductance, with clear steps.

d) Show the variation of all the vector variables on a sinusoidal pattern, in time domain.

e) Calculate the average power dissipated by the circuits.

f) How can the power factor be of useful in the circuit, in terms of its value?

iv) A variable capacitor is connected in series with a circuit consisting of a non-inductive resistance of 123 ohms in parallel with a coil across a 189 V, 58 Hz supply. The coil has an inductance of 2.53 H. *(30 marks)*

(a) State the assumption that you would make at the start of the sum.

(b) Calculate the capacitance of the capacitor, when the power factor of the circuit is unity.

(c) Compute the corresponding potential difference across the capacitor. Draw the vector diagram, to scale, representing all the voltage and currents.

(d) Draw the vector polygon to indicate the resultant vector.

5) i) Distinguish active power, apparent power and reactive power, along with their units. *(10 marks)*

ii) Discuss a practical application mathematically where active power, reactive power and apparent power be used. *(10 marks)*

iii) The excited voltage is 95.75V to a circuit, and is found to lag the current by 30^0 *(40 marks)*

a) Comment on the nature of the power factor concerned.

b) Compute the magnitude of the power factor, and discuss its possible variation?

c) Deduce whether the circuit is to be either inductive or capacitive.

d) Find the active and reactive power associated with the circuit, from first principles.

iv) a) What is electrical resonance? And derive an expression for the resonant frequency, differentiating the serial and the parallel resonance. *(40 marks)*

b) Describe the following graphically, in account of the resonant curve,

Quality Factor / Degree of Merit
Selectivity
Sharpness
Bandwidth
Half Power Points
Power Factor at Resonance

c)

An inductor having an inductance of 30.456 mH and resistance 8.45 ohms is connected in series with a 28.754 μF capacitor across a 198.789 V AC supply. Thus, find numerically the resonance frequency of the system, current at resonance and the Degree of Merit. Hence or otherwise, explain the bandwidth of the said application as well.

6) i) (a) Distinguish RMS value, average value and the rectified average value of a wave mathematically, and also in terms of their physical significance. *(5 marks)*

(b) Derive the expressions for the RMS and the Average values for a sinusoidal wave form. *(5 marks)*

ii) Determine the effective value of the following waveform. *(20 marks)*

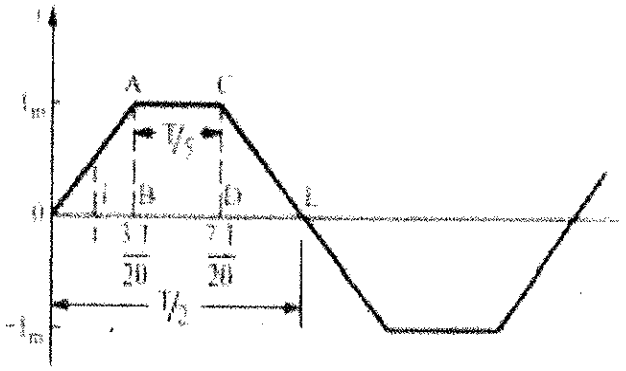

Figure Q 6.1

iii) *(20 marks)*

A delayed full- wave rectified sinusoidal current is observed with an average value of half the maximum value. Thus, find the delay angle

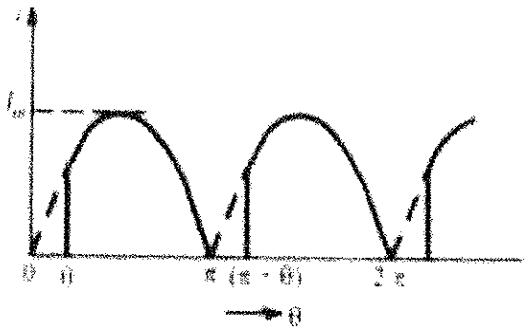

Figure Q 6.2

iv) *(50 marks)*

Determine the branch voltages, currents and power delivered by the source, with respect to the given circuit below. Draw the corresponding phasor diagram to indicate all the voltage and the current variables.

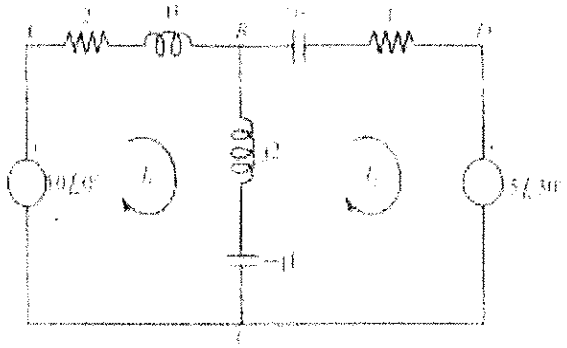

Figure 6.3