MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 203: CIRCUIT THEORY I

DATE: 16/8/2021 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS:

1. *This paper contains 5 questions.*
2. *Attempt **Question One** and **Any Other Two questions***

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Briefly explain the following terms as used in circuit analysis:
   (i) Circuit (1 mark)
   (ii) Node (1 mark)
   (iii)Loop (1 mark)
   (iv)Mesh (1 mark)

b) State the two the Kirchhoff's laws (2 marks)

c) For the circuit shown in Fig. Q1 c), use Kirchhoff's laws to find
   (i) The currents I_1 and I_2 (4 marks)
   (ii) Voltage across the $10\,\Omega$ resistor (1 mark)
   (iii)Power dissipated in the $2\,\Omega$ resistor (1 mark)

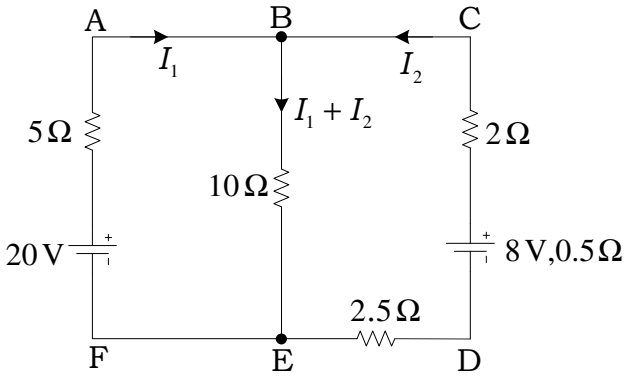

Fig. Q1c)

d) A resistance of $50\,\Omega$ and an inductance of 0.1H are connected in series across a $230\,\text{V}$ 50 Hz supply. Find

(i) Circuit impedance (1½ marks)
(ii) Circuit Current (1 mark)
(iii) power factor (½ mark)
(iv) apparent power (1 mark)
(v) active power (1 mark)
(vi) reactive power (1 mark)
(vii) voltage across resistance and (1 mark)
(viii) voltage across inductance (1 mark)

e) For the circuit shown in Fig. Q 1 e), use nodal analysis to find

(i) Currents I_1, I_2, I_3, I_4 and I_5 (8 marks)
(ii) the voltage across the $25\,\Omega$ resistor (1 mark)
(iii) the total power consumed by the passive elements of the circuit (1 mark)

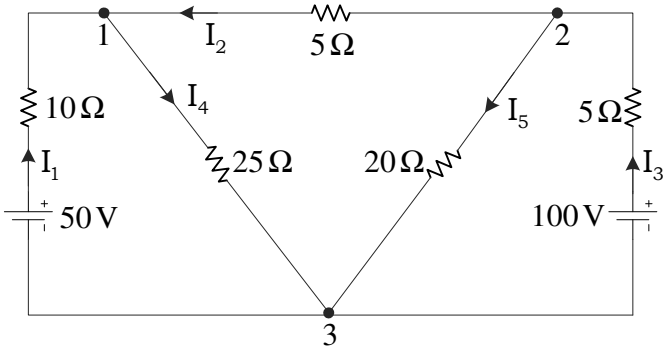

Fig. Q1e)

QUESTION TWO (20 MARKS)

a) A capacitance $C = 35\,\mu F$ is in parallel with a resistor R. Find the value of R given that the circuit voltage and total circuit current are
$v = 150\sin 3000t\,(V)$ and $i = 16.5\sin\left(3000t + 72.4^0\right)$(A) respectively. (5 marks)

b) For the circuit shown in Fig.Q2 b), use Ohms law to find
(i) Total circuit resistance (2 marks)
(ii) Circuit current I (1 mark)
(iii) Currents I_1, I_2, I_3 and I_4 (4 marks)
(iv) Voltage across $9.25\ \Omega$ (1 mark)

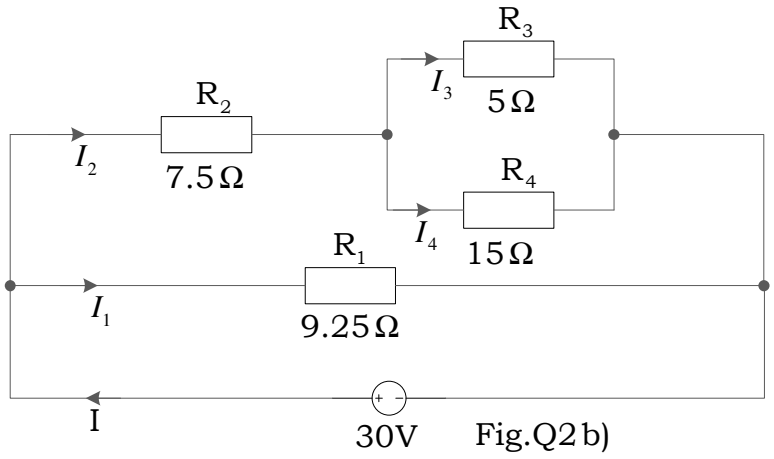

Fig.Q2 b)

c) Find the Thevenin's equivalent of the circuit shown in Fig. Q2 c) at terminals A-B. Hence, calculate
(i) the value of the current flowing through $(10 + j30)\,\Omega$ impedance
(ii) the power dissipated in this impedance. (7 marks)

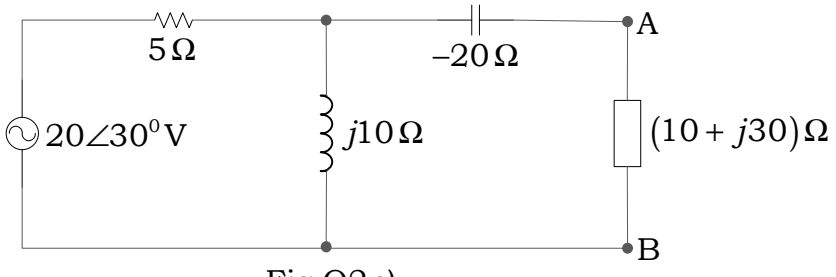

Fig.Q2 c)

QUESTION THREE (20 MARKS)

a) Find the value of R_L for maximum power transfer in Fig. Q3 a). Also find this power. (4 marks)

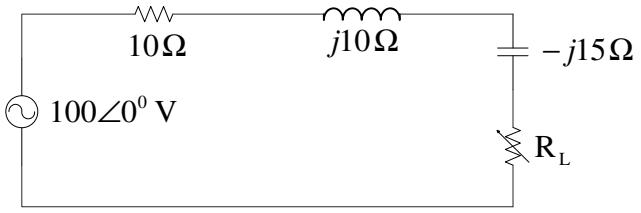

Fig. Q3 a)

b) When a voltage $v = 15\sin\left(1000t - 30^0\right)\text{V}$ is applied to a series ac circuit, the current is $i = 10\sin\left(1000t - 10^0\right)\text{A}$. Find

(i) power factor (1 mark)
(ii) apparent power (1 mark)
(iii) Active power (1 mark)
(iv) Circuit parameters (4 marks)

c) For the circuit shown in Fig. Q3 c), find

(i) Mesh currents I_1 and I_2 (5 marks)
(ii) The voltage, V_c (1 mark)
(iii) Power dissipated in the $25\,\Omega$ resistor (1 mark)

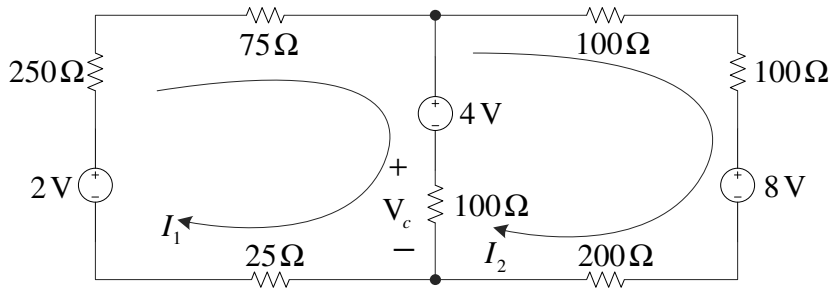

Fig. Q3 c)

d) Determine the resistance range for the following colour code: Blue-Brown-Green-Silver-Blue. (2 marks)

QUESTION FOUR (20 MARKS)

a) For the circuit shown in Fig. Q4 a), find

(i) Total circuit impedance (2 marks)
(ii) Current drawn from supply (1 mark)
(iii) Voltage across the parallel branches (1 mark)
(iv) Current in each parallel branch (2 marks)
(v) Power factor (1 mark)
(vi) Apparent power (1 mark)
(vii) Active power (1 mark)
(viii) Draw the phasor diagram showing V, I, I_1 and I_2. (2 marks)

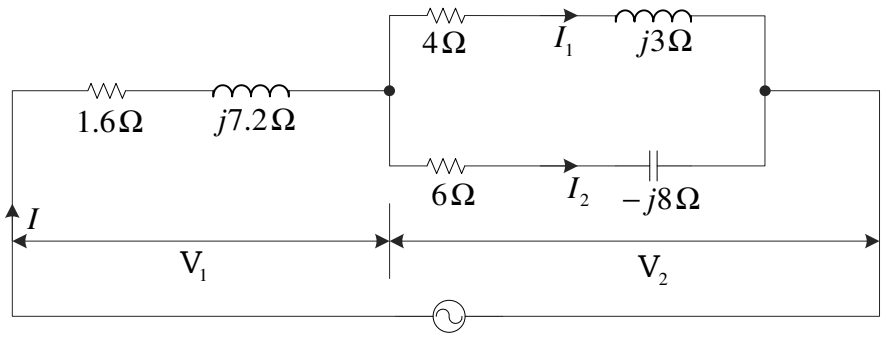

Fig. Q4 a)

b) Use Norton's theorem to find the current through the R_L in Fig. Q4 b).

(5 marks)

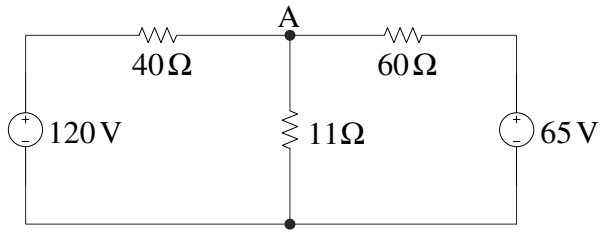

Fig. Q4 b)

c) Two resistors are connected in series across a 24 V supply and a current of 3 A flows in the circuit. If one of the resistors has a resistance of 2Ω, determine

(i) the value of the other resistor, and
(ii) the p.d. across the 2Ω resistor.
(iii) how much energy is used if the circuit is connected for 50 hours

(4 marks)

QUESTION FIVE (20 MARKS)

a) A parallel circuit having a resistance of $15\,\Omega$ in one branch and an inductance of L in the other is fed from a 240 V, 50 Hz supply. The total circuit current is 22.1 A.

(i) Find the value of the inductance (4 marks)

(ii) What should be the frequency for the total current to be 34 A? (3 marks)

b) State the Superposition theorem. (2 marks)

c) Using the superposition theorem, find the voltage across the $20\,\Omega$ in the circuit of Fig. Q5 c). (5 marks)

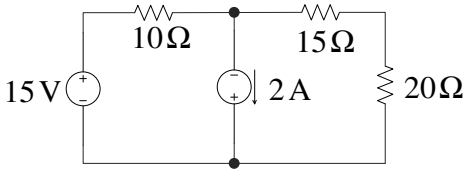

Fig. Q5 c)

d) Three voltages represented by $v_1 = 20\sin\omega t;\ v_2 = 30\sin\left(\omega t - \pi/4\right);\ v_3 = 40\cos\left(\omega t + \pi/6\right)$ act together in a circuit.

(i) Draw the waveforms for the three voltages (2 marks)

(ii) Find an expression for the resultant voltage. (4 marks)