MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE
IN
MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 201

COURSE TITLE: CIRCUIT THEORY

DATE: THURSDAY 07/12/2023 TIME: 12: 00 PM – 2:00 PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 5 Printed Pages. Please Turn Over.

Question One (30 marks)

(a) Define the following terms:
   i) Mesh
   ii) Loop
   iii) Node   **[3 marks]**

(b) If $100\angle0°$ a.c is supplied to a circuit consisting of a 3Ω resistor and 4Ω capacitive reactance connected in series, determine the voltage across each element in the circuit.   **[3 marks]**

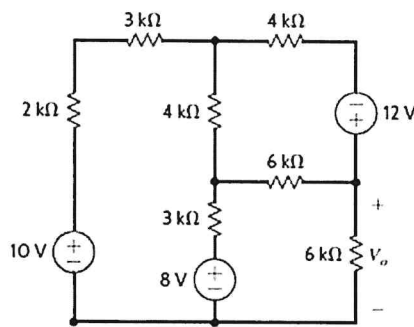(c) From fig. 1.1 below, use mesh analysis to find the mesh currents and voltage v_o. **[5 marks]**

Figure 1.1

(d) With the help of illustrations, use the superposition principle to determine the value of i_x.
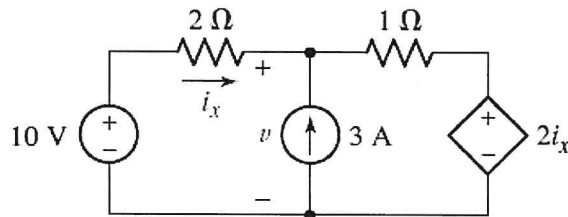

Figure 1.2

[6 marks]

(e) For the circuit in Figure 1.3 below, compute the voltage across each current source using the supernode method of analysis.   **[6 marks]**
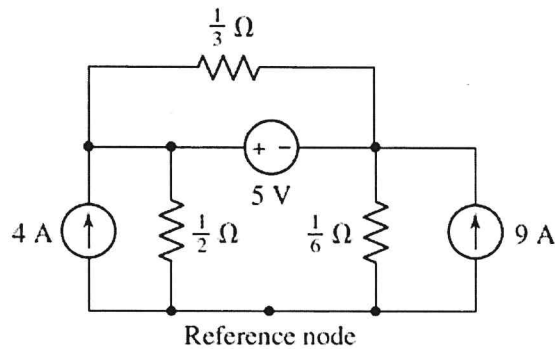

Figure 1.3

(e) A 230V, 50Hz a.c. supply is applied to a coil of 0.06H inductance and 2.5Ω resistance connected in series with a $6·8\mu F$ capacitor. Determine;

i) Impedance   [3 marks]
ii) Current flowing through the circuit   [1 mark]
iii) Phase angle between current and voltage   [2 marks]
iv) Power factor.   [1marks]

Question Two (20 marks)

a) Name and state Kirchhoff's laws.   [3 marks]

b) Determine the value of current in each branch when three resistors of values 3Ω, 2Ω and 4Ω are connected in parallel. The total input current fed to the resistors is 8A.   [4 marks]

c) In the circuit below, use resistance combination methods and current division to find i_1, i_2 and v_3.   [7 marks]
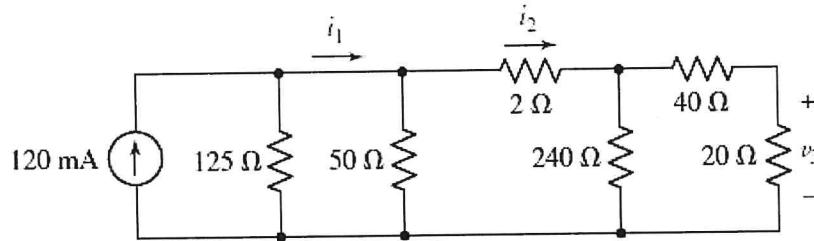

Figure 2.1

d) Determine the current i_1 in the circuit below using supermesh method.   [6 marks]

Figure 2.2

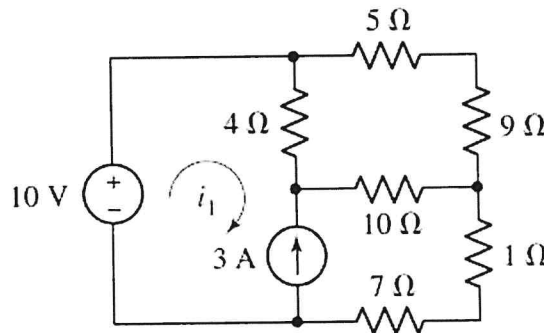## Question Three (20 marks)

(a) i) State Thevenin's Theorem.   [1 mark]

ii) From Figure 3.1, use Thevenin's Theorem to find:

I. V_{TH} and R_{TH},   [3 marks]
II. the load current I_L flowing through the circuit,   [2 marks]
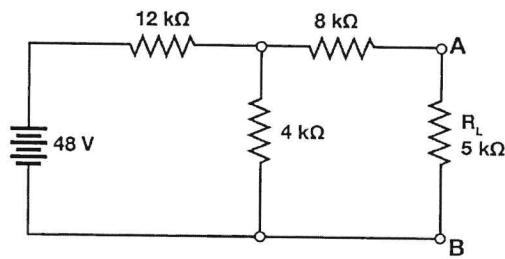III. the load voltage across the load resistor in the circuit below.   [2 marks]

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Figure 3.1

(b) i) Explain mesh analysis. **[2 marks]**

ii) Using the method explained above, determine the mesh currents in fig.3.2. **[4 marks]**
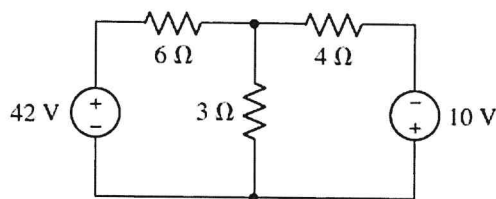

Figure 3.2

(c) For the single-node-pair circuit below, find i_A, i_B and i_C. **[6 marks]**
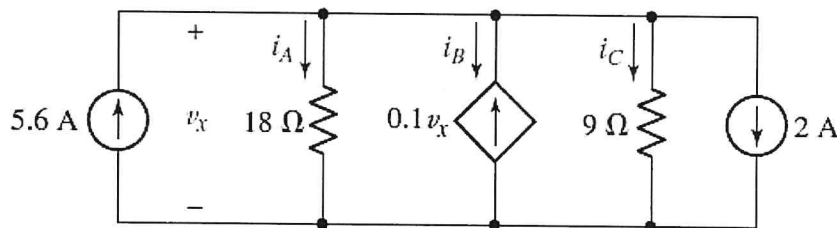

Figure 3.3

Question Four (20 marks)

(a) The peak value of a sinusoidal voltage is 12V and it has a periodic time of 16milliseconds. Determine the;

   i) r.m.s value **[1mark]**

   ii) average value **[1mark]**

   iii) frequency of supply. **[1mark]**

(b) A series RLC circuit containing a resistance of 12Ω, an inductance of $0.15H$ and a capacitor of $100\mu F$ are connected in series across a 100V, 50Hz supply.

   i) draw the circuit, **[1 mark]**

   ii) calculate the total circuit impedance, **[3.5 marks]**

   iii) determine the circuit current and voltage across each component, **[2.5 marks]**

   iv) calculate the power factor, **[1 mark]**

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v) draw the voltage phasor diagram. **[2 marks]**

(c) For the circuit in fig. 4.1, calculate:

    i)   the current I, **[4.5 marks]**

    ii)   voltages v_R, v_L and v_C in phasor form, **[1.5 marks]**

    iii) the total power factor. **[1 mark]**

$C_1 = 200\,\mu F \quad C_2 = 200\,\mu F$

$R_1 = 6\,\Omega \quad R_2 = 4\,\Omega \quad L_1 = 0.05\,H \quad L_2 = 0.05\,H$

$e = \sqrt{2}(20)\sin 377t$

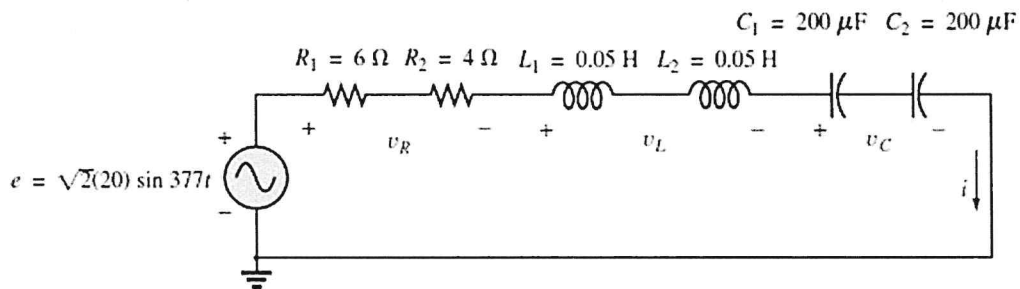**Figure 4.1**

Question Five (20 marks)

a) Use mesh analysis to determine the current i_1 in the circuit of fig.5.1. **[5 marks]**

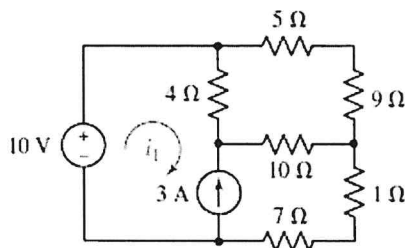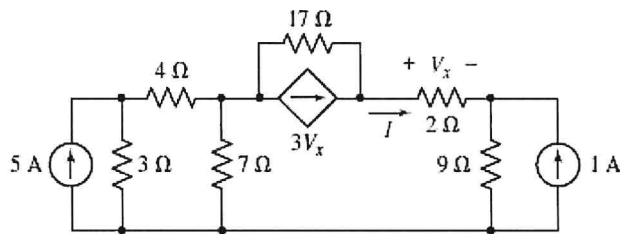Figure 5.1   Figure 5.2

b) Calculate the current through the 2Ω resistor in Fig. 5.2 by making use of source transformations to first simplify the circuit. **[5 marks]**

c) Given that the elements $v_{s1} = -120\ V, v_{s2} = 30\ V, R_1 = 30\ \Omega\ and\ R_2 = 15\ \Omega$ are all connected in series in a circuit, compute the power absorbed by each element. **[5 marks]**

d) Considering the network shown in fig.5.3 below, find the branch currents $I_1, I_2\ and\ I_3$, using the supernode analysis method. **[5 marks]**
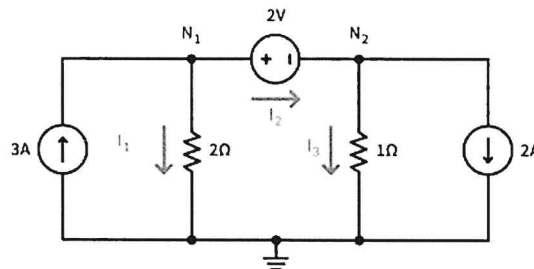

Figure 5.3

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