Ref No.:Ex/EE/5/T/112/2024

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FIRST YEAR FIRST SEMESTER - 2024

SUBJECT: CIRCUIT THEORY

Time: Three Hours

Full Marks: 100
(50 Marks for each part)

Use a separate Answer-Script for each part

Two marks for neat and well-organized answers

Question No.	Part-I	Marks

Answer any three questions

1. (a) Define a unit step function and unit ramp function. What is the relationship between the two singularity functions? — 8

(b) "The inductor can be represented as an open circuit at t = 0+ & The capacitor can be represented as a short circuit at t = 0+" – Explain. — 8

2. (a) The voltage across the capacitor in the Fig. 1 is given as follows: $v_c(t) = 2r(t) - 2r(t-1)$. Find the value of the voltage source Vs in terms of singularity functions and sketch it. — 8

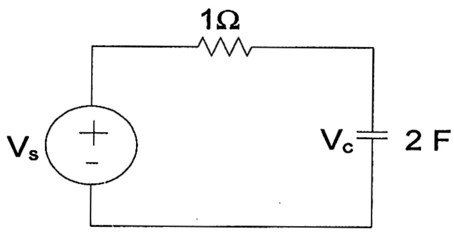

Fig. 1

(b) Derive and draw the equivalent circuit of the Laplace transformation of inductance and capacitance with initial conditions. — 8

3. (a) For the circuit shown in Fig.2, steady state is reached with the switch closed. At t=0, the switch is opened. In this condition, find $i_1(0+), i_2(0+), i_1'(0+)$ and $i_2'(0+)$. — 8

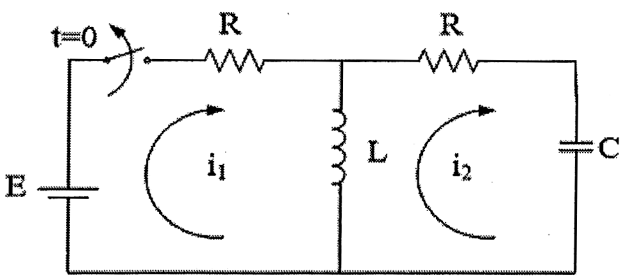

Fig. 2

[Turn over

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(b) State and derive the initial value theorem. Find the initial and final values of the following function using initial and final value theorem, respectively. 8

$$F(s) = \frac{s-1}{(s-2)(s+4)}$$

4. (a) Find the Laplace transform of the following three signals as shown in Fig. 3: 3×4

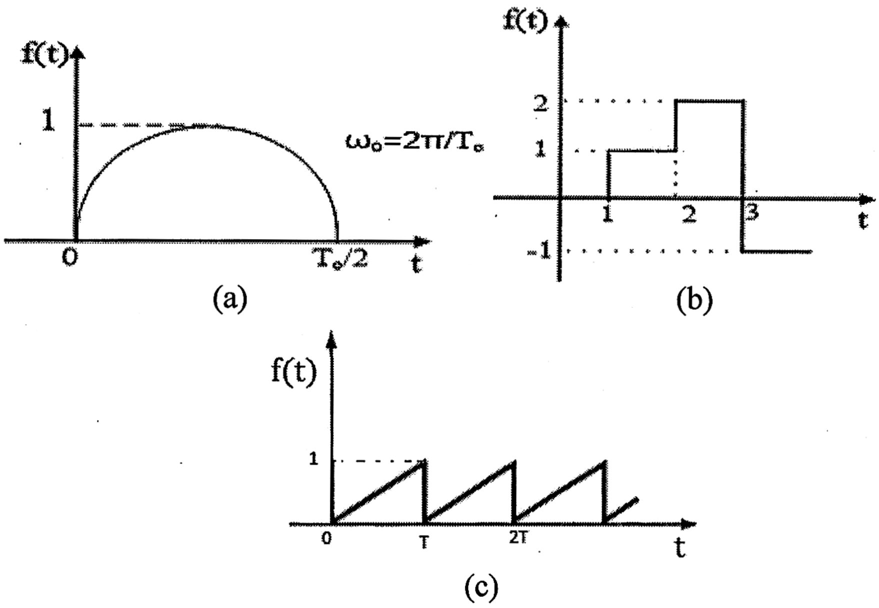

Fig. 3

(b) What do you understand by the terms 'terminals' and 'port' in connection to networks? 4

5. (a) Draw a two port network whose ABCD parameters are A=2,B=1 ohm, C=1 mho, D=2. If two such networks are cascaded, determine the ABCD parameter of the overall network. 7

(b) Obtain the ABCD parameters in terms of Z parameters of a two-port network. 9

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Part II (50 marks)

Question No. | ***Question 1 is compulsory*** | Marks

Answer *Any Two* questions from the rest (2×20)

Q1 Answer ***Any One*** : (a) ***or*** (b)

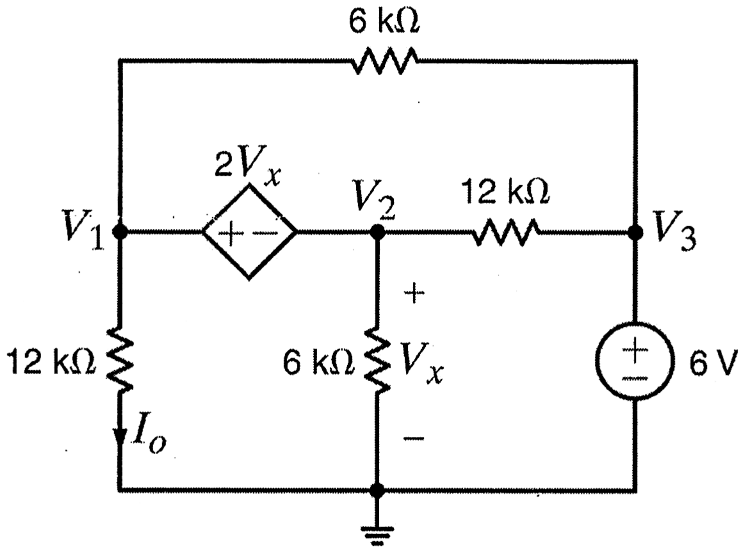

Figure Q1

(a) Determine the value of the current I_0 using Loop Analysis technique. 10

OR

(b) Determine the value of the current I_0 using Nodal Analysis technique. 10

Q2 (a) For the circuit shown in Figure Q2(a) to find I_0. 8

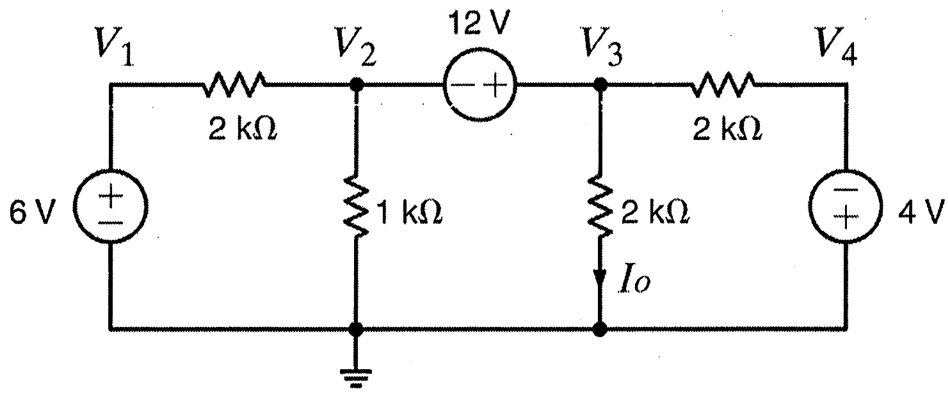

Figure Q2(a)

(b) State and prove Maximum Power Transfer Theorem. 4

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Q2 (c) For the circuit, as shown in Figure Q2(c), find the value of R that results in maximum power absorbed by R for (i) $\beta = 0.5$ and (ii) $\beta = 1.5$. 4+4

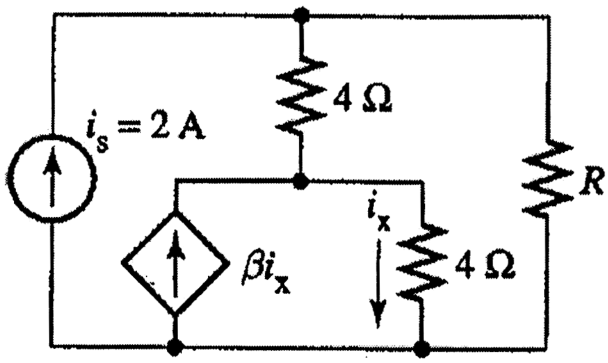

Figure Q2(c)

Q3 (a) Find, using source superposition, the value of V_0 for the circuit shown in Figure Q3(a). 8

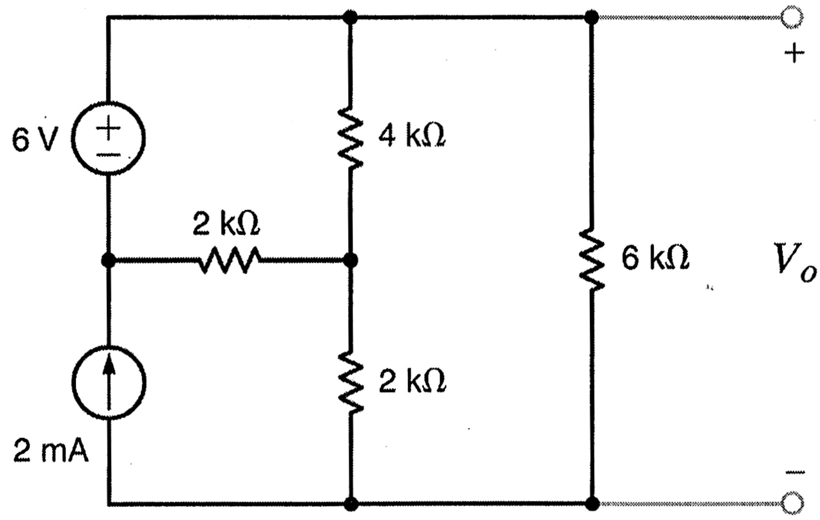

Figure Q3(a)

(b) Two mutually coupled inductors are connected across a voltage source, as shown in Figure Q3(b). Obtain the equivalent inductance of the circuit. 4

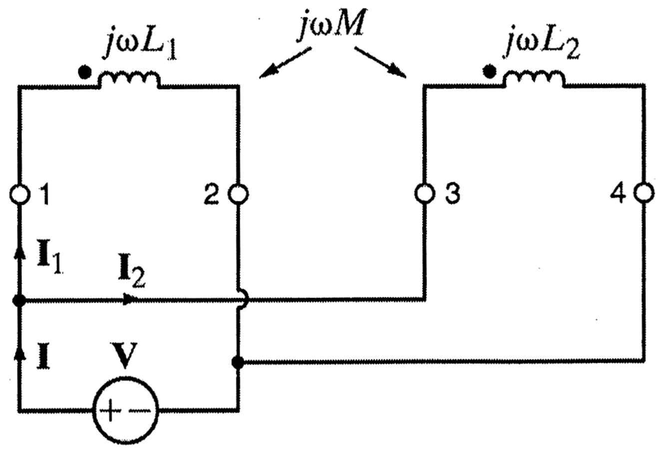

Figure Q3(b)

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Q3 (c) Calculate the mesh currents I_1 and I_2 in the circuit shown in Figure Q3(c). 8

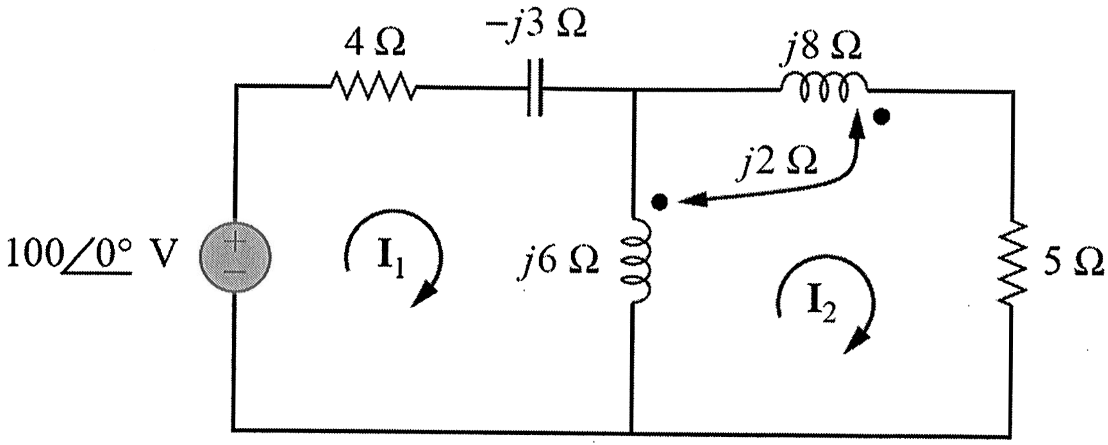

Figure Q3(c)

Q4 (a) Consider the circuit shown in Figure Q4(a) that contains a current-controlled-current-source. Find the value of current i. 6

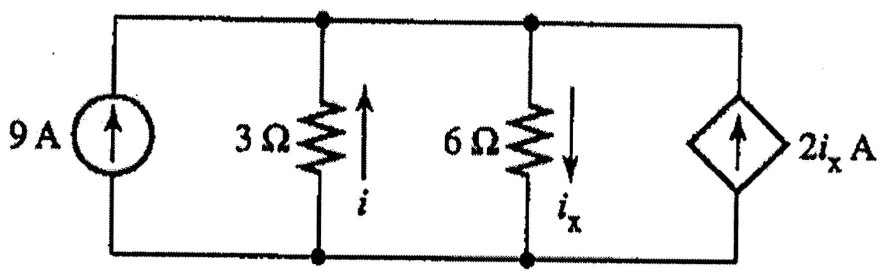

Figure Q4(a)

(b) Draw the graph and obtain the Incidence Matrix for the network shown in Figure Q4(b). 4

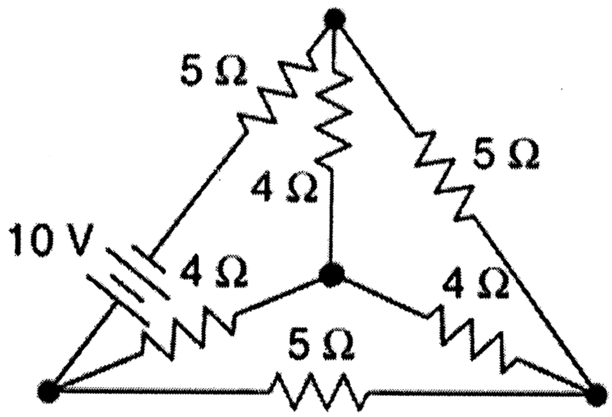

Figure Q4(b)

(c) Define Cut-set for a network graph.

With the help of an example, show how Kirchhoff's Current Law can be written in terms of basic Cut-Set matrix. 2+8

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Q5 (a) Assume that a steady state has been reached before the switch is operated at t= 0, as shown in the circuit in Figure Q5(a).

Using Laplace Transform technique obtain the expression for $V_0(s)$. 8

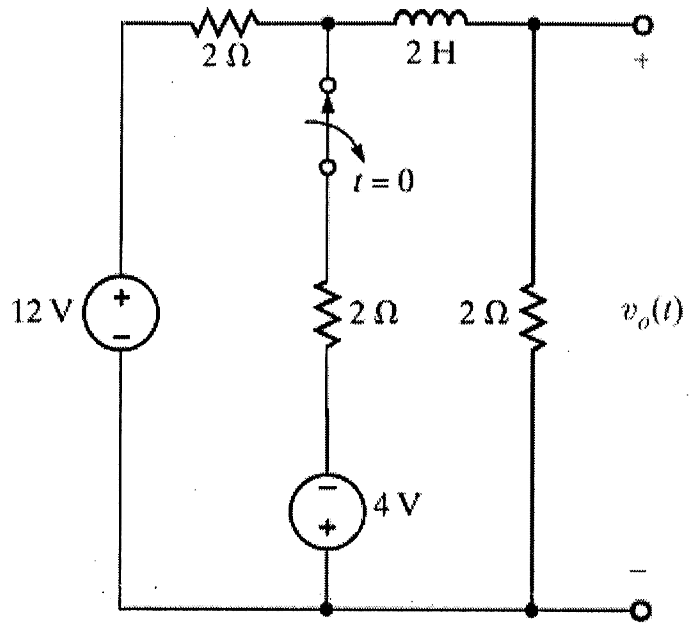

Figure Q5(a)

(b) For the network shown in the Figure Q5(b), draw the oriented graph and obtain the Tie-Set Matrix. 8

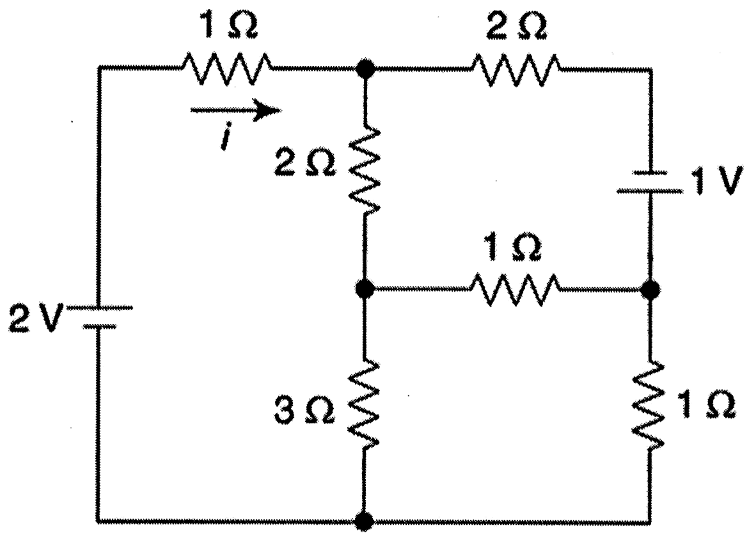

Figure Q5(b)

(c) Find the total inductance of the series coils shown in Figure Q5(c). 4

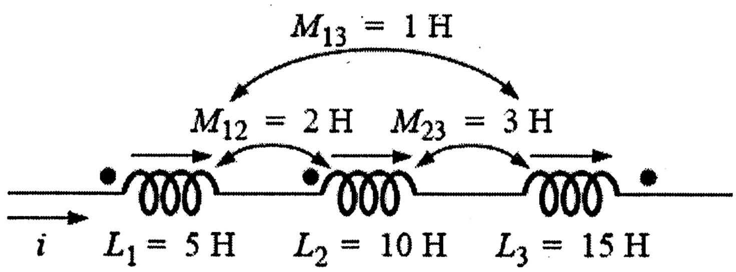

Figure Q5(c)