CIRCUIT THEORY
(ELEC 2101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Supermesh analysis is based on
(a) KCL (b) KVL
(c) both KVL & KCL (d) law of conservation of energy

(ii) For perfect or ideal coupling, the value of the coefficient of coupling of two magnetically coupled coils is
(a) 1 (b) 2 (c) 0.1 (d) 0.2

(iii) The Laplace transform of a unit impulse function is
(a) $\frac{1}{s}$ (b) $\frac{1}{s^2}$ (c) 1 (d) s

(iv) Integration of step signal gives
(a) Impulse signal (b) Ramp signal
(c) Sinusoidal signal (d) Parabolic signal

(v) The time constant of an R-L circuit is
(a) RL (b) $\frac{R}{L}$ (c) $\frac{L}{R}$ (d) L

(vi) A two-port network is symmetrical if and only if
(a) $Z_{11} = Z_{22}$ (b) BC - AD= -1 (c) $Y_{12} = -Y_{21}$ (d) $h_{12} = h_{21}$

(vii) A network has 8 branches and 5 nodes. The number of fundamental cut-set in the network would be
(a) 6 (b) 5 (c) 4 (d) 3

(viii) The fundamental cut-set matrix gives the relation between
(a) branch voltages and branch currents
(b) branch voltages and twig voltages
(c) branch currents and link currents
(d) link voltages and link currents

(ix) The transfer function of a normalised 3rd order Butterworth low-pass filter is

(a) $\frac{1}{(s+1)(s^2+2s+1)}$ (b) $\frac{1}{(s+1)(s^2+\sqrt{2}s+1)}$

(c) $\frac{100}{(s+10)(s^2+10\sqrt{2}s+100)}$ (d) $\frac{1}{(s+1)(s^2+s+1)}$

(x) The d.c. gain of a system represented by the transfer function $\frac{10}{(s+1)(s+2)}$ is

(a) 1 (b) 2 (c) 5 (d) 10

Group – B

2. (a) Calculate mesh currents for the circuit of Fig. 2(a).

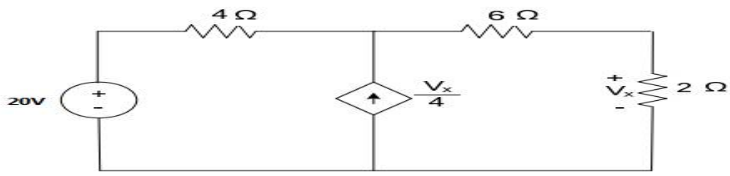

Fig. 2(a)

(b) Calculate the current through 1Ω resistance using Norton's theorem for the circuit of fig. 2(b).

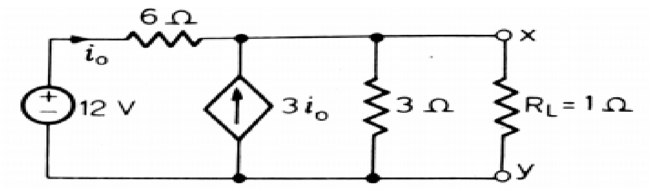

Fig. 2(b)

(c) In the circuit of fig. 2(c), the load consists of pure resistance R_L. Calculate the value of R_L for which the source delivers maximum power to the load.

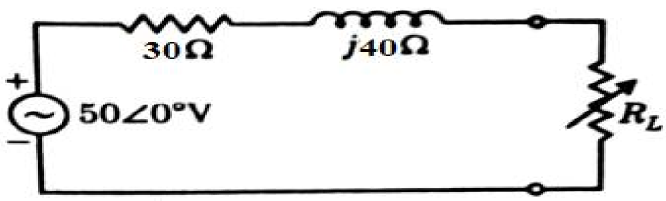

Fig. 2(c)

4 + 6 + 2 = 12

3. (a) For the circuit shown in fig. 3(a), use superposition theorem to calculate the value of *i*.

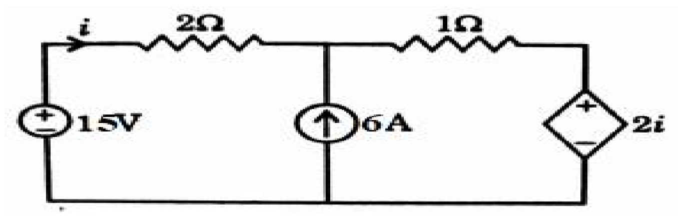

Fig. 3(a)

(b) Determine the current in 5 Ω resistance in the magnetically coupled circuit as shown in fig. 3(b).

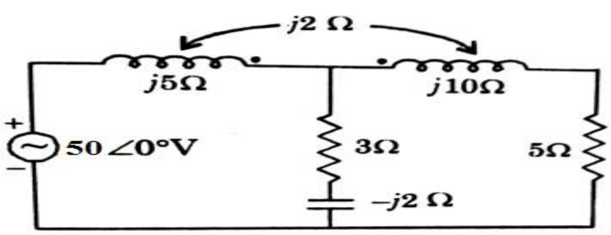

Fig. 3(b)

6 + 6 = 12

Group – C

4. (a) Determine Laplace transform of the waveform shown in fig. 4(a).

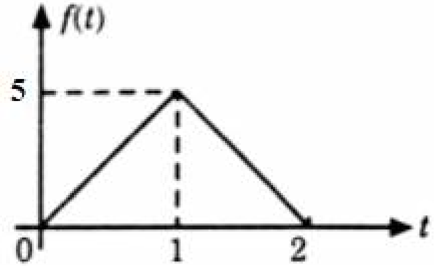

Fig. 4(a)

(b) In the series R-L-C circuit shown in figure 4(b), the switch S is closed at $t = 0$. There is no initial charge on the capacitor. Determine the resulting current for $t > 0$. Also determine the nature of damping occurring in the circuit.

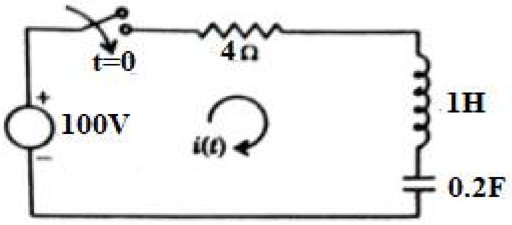

Fig. 4(b)

5 + (6 + 1) = 12

5. (a) In the network shown in fig. 5(a), the switch 'S' is closed and a steady state is reached in the network. At time $t = 0$, the switch is opened. Determine $i(t)$ for $t > 0$.

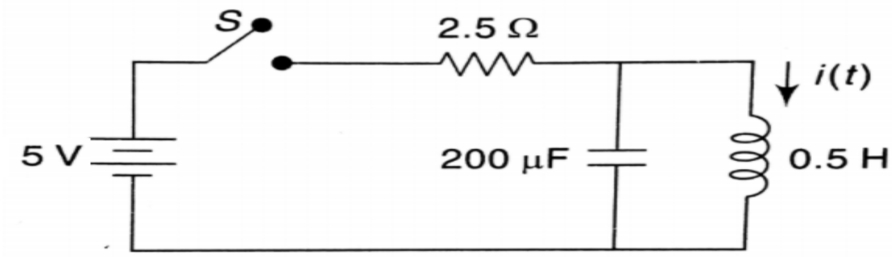

Fig. 5(a)

(b) Determine the signal $f(t)$ whose first derivative is as shown in the fig. 5(b). Also sketch waveform of $f(t)$.

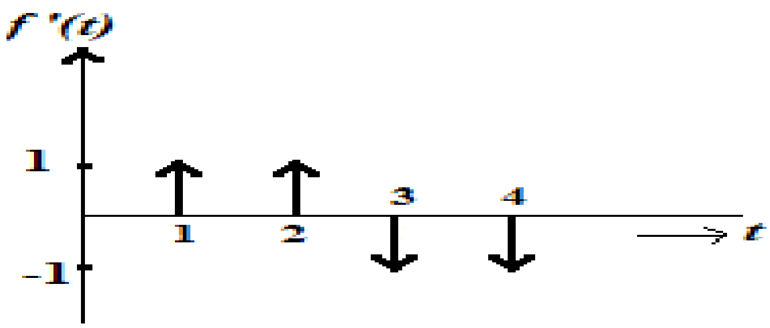

Fig. 5(b)

7 + 5 = 12

Group – D

6. (a) State the properties of Complete Incidence Matrix.

(b) Draw the oriented graph for the circuit shown in Fig. 6(b). Find its complete incidence matrix and Tie-set matrix. Assume the sub-graph shown in figure below as a tree. Use graph theory to find mesh equations for the circuit.

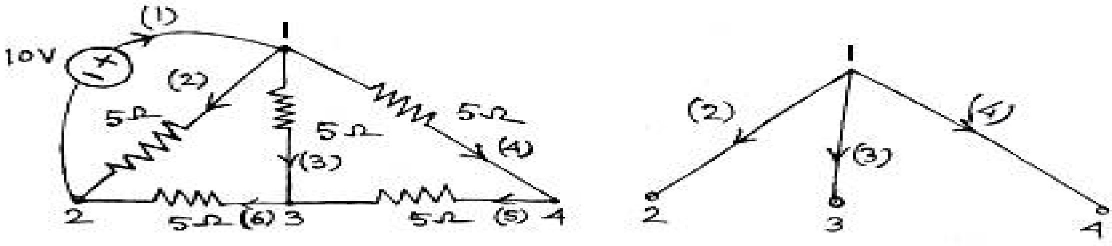

Fig. 6(b)

3 + (1 + 2 + 2 + 4) = 12

7. (a) Define Z-parameters. Express Z-parameters in terms of Y-parameters and transmission parameters.

(b) Determine Z-parameters, Y-parameters and ABCD- parameters of the circuit shown in Fig. (7b).

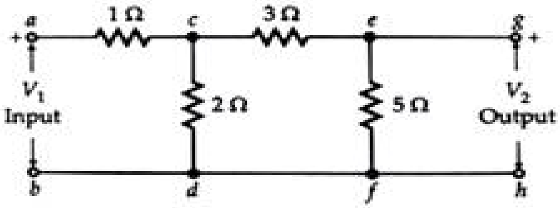

Fig. (7b)

(2 + 2 + 2) + (2 + 2 + 2) = 12

Group – E

8. (a) Draw the circuit diagram of a notch filter. Derive the expression transfer function and centre frequency of this filter. Sketch its frequency response curve.

(b) Design a 2nd order Butterworth low pass filter of cut-off frequency 1kHz.

(1 + 6 + 1 + 1) + 3 = 12

9. Determine the poles of 5th order Butterworth filter. Sketch the location of poles on s-plane and hence determine the normalized transfer function of the low pass filter.

(5 + 3 + 4) = 12

Department & Section	Submission Link
EE regular students	https://classroom.google.com/c/MTIxOTk2MTM4MTk3/a/MjcxNTUwMTc1NTE2/details
EE backlog students	https://classroom.google.com/c/MjQ4NTI4MDE2NjE4/a/Mjc0MDYyNDI4NTE5/details