FUNDAMENTALS OF CIRCUIT THEORY
(ELEC 3221)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Superposition theorem can be applied only to circuits having
(a) resistive elements (b) passive elements
(c) non-linear elements (d) linear bilateral elements

(ii) For maximum transfer of power in ac circuit, the load impedance will be equal to
(a) source impedance (b) complex conjugate of the source impedance
(c) source resistance (d) source reactance

(iii) The superposition theorem requires as many times to be solved as there are
(a) meshes (b) nodes (c) sources (d) independent sources

(iv) The Laplace transform of a function is $F(s) = \frac{2s}{s^2+2s+5}$. Its initial value is
(a) 4 (b) -2 (c) 2 (d) 0

(v) The inverse Laplace transform of $F(s) = \frac{1}{(s+1)^2+1}$ is
(a) $e^{-t}\ sin\ sin\ t$ (b) $e^{-t}\ cos\ cos\ t$ (c) $sin\ t$ (d) e^{-t}

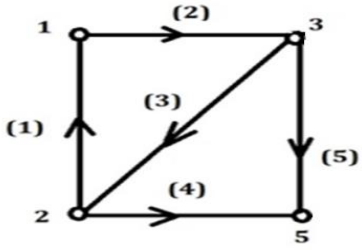
(vi) Z_{21} in terms of Y parameter is
(a) $\frac{-Y_{22}}{\Delta Y}$ (b) $\frac{-Y_{12}}{\Delta Y}$ (c) $\frac{-Y_{11}}{\Delta Y}$ (d) $\frac{-Y_{21}}{\Delta Y}$

(vii) A cut-set of a graph represents
(a) A set of branches whose removal disconnects the graph
(b) A set of branches forming a loop
(c) A minimal path in a circuit
(d) The total number of edges in a circuit

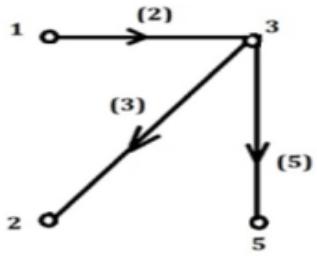
(viii) Which among the following represents the precise condition of reciprocity of ABCD parameters?
(a) AB-BD=1 (b) AC-BD=1 (c) BC-AD=1 (d) AD-BC=1

(ix) If a two-port network is reciprocal, which condition must be satisfied for its Z-parameters?
(a) $Z_{11} = Z_{22}$ (b) $Z_{12} = Z_{21}$ (c) $Z_{11} + Z_{22} = 0$ (d) $Z_{11} - Z_{22} = 0$

(x) Which of the given options is not a tree of the following graph?



(a)



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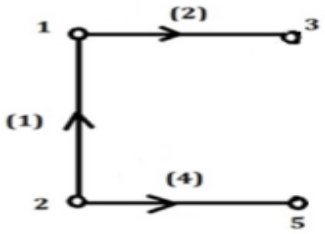

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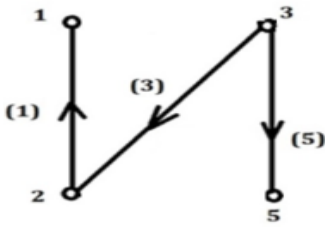

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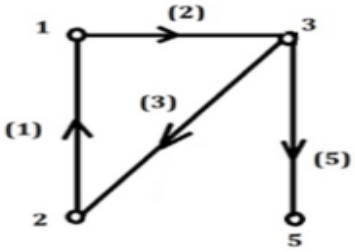

Fill in the blanks with the correct word

(xi) The Thevenin's equivalent circuit consists of a voltage source in series with a _____.

(xii) In a dc network the efficiency under maximum power transfer condition is_____.

(xiii) In an RL series circuit having R=2Ω and L=2mH, a dc voltage of 10V is applied at t=0. The value of steady- state current is_____.

(xiv) A graph consists of _____ and _____, representing circuit elements and connections.

(xv) In Z-parameter representation the output driving point impedance is _____.

Group - B

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

[(CO1)(Apply/IOCQ)]

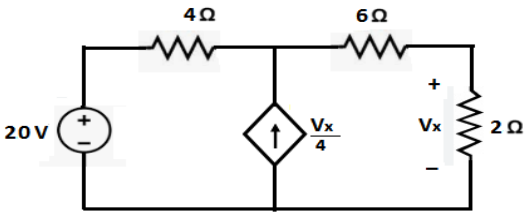

Fig. 2(a)

(b) Obtain Thevenin's equivalent circuit across X-Y terminals for the circuit of Fig. 2(b).

[(CO2)(Apply/IOCQ)]

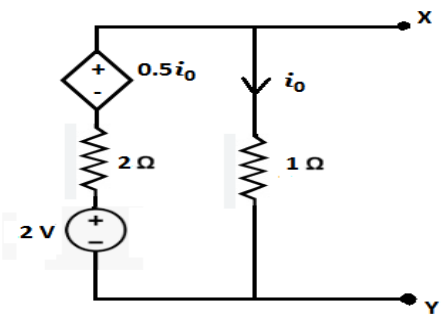

Fig. 2(b)

6 + 6 = 12

3. (a) Find the value of R_L in the circuit of Fig. 3(a) for which maximum power transfer can take place from source to load.

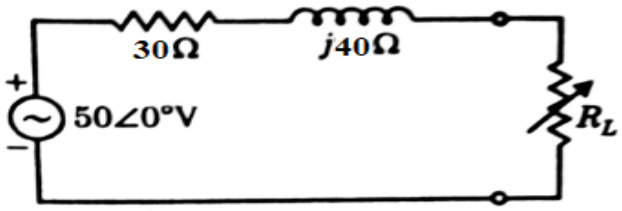

Fig. 3(a) *[(CO2)(Apply/IOCQ)]*

(b) Use superposition theorem to find i_0 for the circuit of Fig. 3(b).

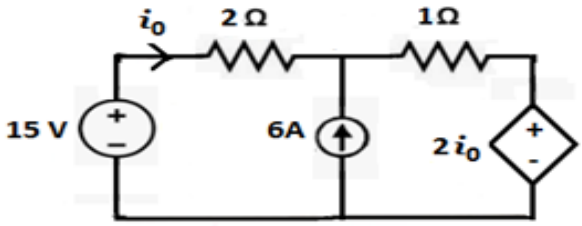

Fig. 3(b) *[(CO2)(Analyse/HOCQ)]*

(c) What is dependent source? What are the different types of dependent source? *[(CO1)(Remember/LOCQ)]*

2 + 6 + (1 + 3) = 12

Group - C

4. (a) Obtain Laplace transform of the given periodic waveform Fig. 4 (a).

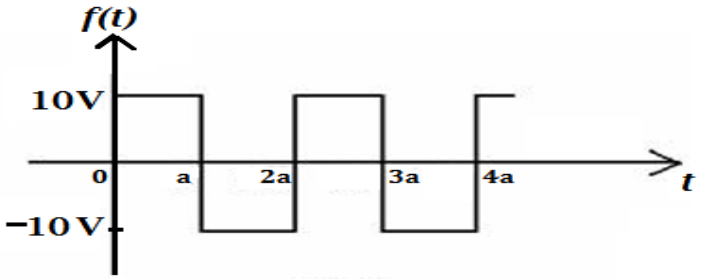

Fig. 4(a) *[(CO3)(Understand/LOCQ)]*

(b) In the series RLC circuit shown in Fig. 4(b), there is no initial charge on the capacitor. If the switch S is closed at t=0, determine the resulting current for $t > 0$.

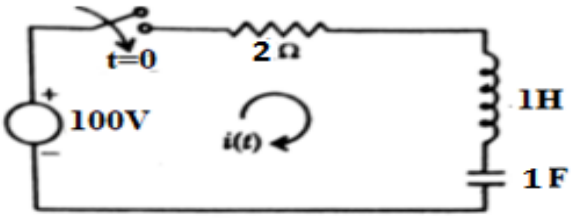

Fig. 4(b) *[(CO4) (Apply/IOCQ)]*

5 + 7 = 12

5. (a) Determine Laplace transform for the staircase waveform as shown in Fig. 5(a).

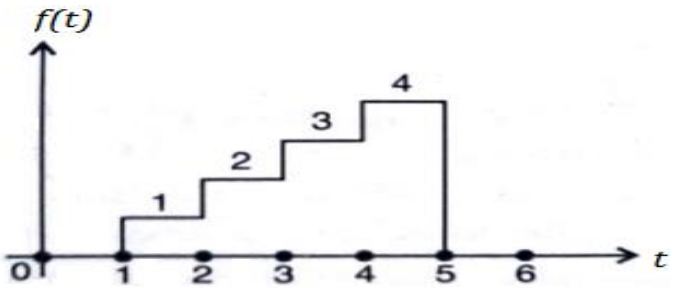

Fig. 5(a) *[(CO3)(Apply/IOCQ)]*

(b) The circuit in Fig. 5(b), is initially at steady- state condition. The switch "s" is moved from position 1 to position 2 at $t = 0$. Determine the expression of the current flowing through the circuit after switching.

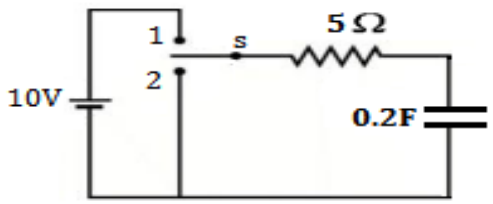

Fig. 5(b)

[(CO4)(Apply/IOCQ)]

5 + 7 = 12

Group - D

6. (a) Develop Complete Incidence matrix of the directed graph shown in Fig. 6(a).

[(CO5) (Create/HOCQ)]

(b) Assume the sub-graph shown in Fig. 6(b) as a tree and develop fundamental Cut-set matrix and Tie-set matrix.

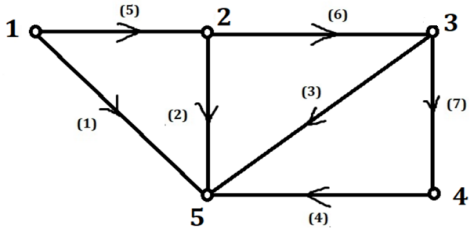

Fig. 6(a)

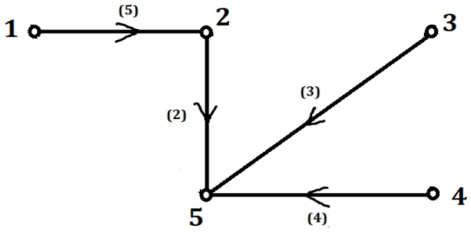

Fig. 6(b)

[(CO5) (Apply/IOCQ)]

4 + (4 + 4) = 12

7. (a) Define node, degree of a node, tree, twig and link of a graph in circuit theory.

[(CO5)(Remember/LOCQ)]

(b) Draw the directed graph for the following incidence matrix.

$$A_a = [-1\ 0\ -1\ 1\ 0\ 0\ 1\ 0\ -1\ 0\ -1\ 0\ -1\ 0\ 1\ 1\ 0\ 0\ -1\ 1\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ -1]$$

[(CO5)(Apply/IOCQ)]

6 + 6 =12

Group - E

8. (a) Define Z-parameters and transmission (ABCD) parameters. Express Z- Parameters in terms of hybrid parameters.

[(CO6)(Remember/LOCQ)]

(b) Analyse the circuit shown in Fig. 8(b) and find its Z-parameters and Y- parameters.

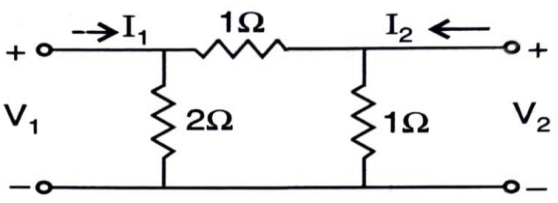

Fig. 8(b)

[(CO6)(Apply/IOCQ)]

(2 + 2 + 2) + 6 = 12

9. (a) For hybrid parameters, develop the condition of Symmetry and Reciprocity.

[(CO6)(Analyse/HOCQ)]

(b) Find Y-parameters in terms of Z- parameters.

[(CO6)(Remember/LOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	28.1	55.2	16.7