Group – D

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

   (b) The incidence matrix of a network is given below. Draw the directed graph of the network and identify any one tree of the graph. Hence, compute its tie-set matrix.

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 & 1 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \end{bmatrix}$$

3 + (5 + 1 + 3) = 12

7. (a) Define Z parameters.

   (b) In a two port network, $Z_{11} = 2\ \Omega$, $Z_{12} = Z_{21} = 5\ \Omega$ and $Z_{22} = 1\ \Omega$. Find (i) Y-parameters (ii) h-parameters and (iii) ABCD parameters.

3 + (3 + 3 + 3) = 12

Group – E

8. (a) Draw and explain the gain vs. frequency characteristics of band pass and band reject filters.

   (b) Design a 2nd order Butterworth low pass filter of cut off frequency 2 kHz. Sketch its frequency response.

4 + (6 + 2) = 12

9. (a) Explain '**.TRAN**' and '**.TF**' statements in SPICE with examples.

   (b) A series LC circuit with L = 1 H and C = 1 F is excited with a 10 V, DC source. Write a SPICE program to plot the voltage across inductor (V_L) and voltage across capacitor (V_c).

(2 + 2) + 8 = 12

CIRCUIT THEORY
(ELEC 2102)

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) The coefficient of coupling for two coils having $L_1 = 2$ H, $L_2 = 8$ H, M = 3 H is
   (a) 0.18 (b) 0.75 (c) 1.33 (d) 5.33.

   (ii) The initial value of f(t) with Laplace transform $F(s) = \frac{(s+2)}{(s+1)(s+3)}$ is
   (a) 3 (b) ∞ (c) 0 (d) 1.

   (iii) An RL series circuit has R = 2 Ω and L = 4 H. Time constant of the circuit is
   (a) 0.5s (b) 1s (c) 2s (d) 4s.

   (iv) The amplitude of Gate signal is
   (a) 1 (b) ∞ (c) 0 (d) not a fixed value.

   (v) The Laplace transform of u(t-1) is
   (a) $\frac{1}{(s+1)}$ (b) $\frac{1}{(s-1)}$ (c) $\frac{e^s}{s}$ (d) $\frac{e^{-s}}{s}$.

   (vi) If a graph has n number of nodes and b number of branches then the number of tie-sets of the graph is equal to
   (a) b - n (b) b + n + 1 (c) b - n + 1 (d) b - n - 1.

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

(viii) The condition of reciprocity for h-parameters is
(a) $h_{11} = h_{22}$ (b) $h_{12} = -h_{21}$
(c) $h_{12}\, h_{21} = h_{11}\, h_{22}$ (d) $h_{12} = h_{21}$.

(ix) The dc gain of a system having transfer function $H(s) = \frac{12}{(s+1)(s+2)}$ is
(a) 12 (b) 6 (c) 3 (d) 2.

(x) **'. AC'** statement in SPICE is use to analyze the network in
(a) frequency domain (b) time domain
(c) both frequency and time domain (d) none of these.

Group – B

2. (a) Use mesh analysis to find the voltage drop across capacitor for the circuit shown in Fig.1.

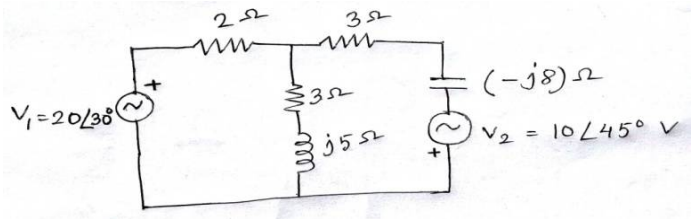

Fig.1

(b) Find the Norton's Equivalent circuit across the terminal AB for the circuit shown in Fig.2.

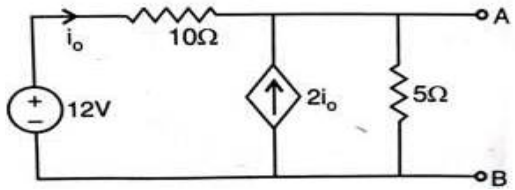

Fig.2

6 + 6 = 12

3. (a) Two inductors having self inductances of L_1 and L_2 and mutual Inductance of M between them are connected in parallel aiding. Show that equivalent inductance is $L_{eq} = \frac{L_1L_2 - M^2}{L_1 + L_2 - 2M}$.

(b) What will be the value of Z_L for the circuit shown in Fig.3 to have maximum power transfer from source to load?

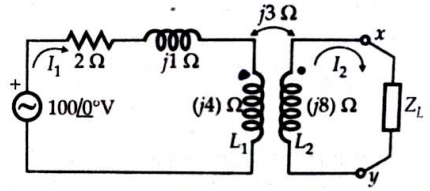

Fig.3

6 + 6 = 12

Group – C

4. (a) Define Unit Step function and find its Laplace transform.

(b) Find Laplace transform of the waveform shown in Fig.4.

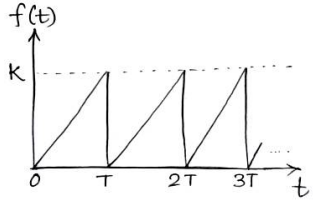

Fig.4

(2 + 2) + 8 = 12

5. (a) Find f(t) where f(t) is the Laplace inverse of $F(s) = \frac{1}{1 - e^{-sT}}$.

(b) Find $V_c(t)$ and $I_L(t)$ in the circuit shown in Fig.5, assume the network is initially relaxed.

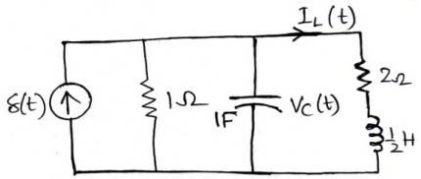

Fig.5

3 + 9 = 12