

**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 $L_1 = 1\text{H}$, $L_2 = 4\text{H}$, $M = 1\text{H}$ is:
(a) 0.25 (b) 0.75 (c) 1 (d) 0.5.
- (ii) The initial value of $f(t)$ with Laplace transform $F(s) = \frac{(s+2)}{(s+1)(s+4)}$ is
(a) 3 (b) ∞ (c) 0 (d) 1.
- (iii) An RL series circuit has $R = 4\Omega$ and $L = 2\text{H}$. 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 $u(t-3)$ is
(a) $\frac{1}{(s+3)}$ (b) $\frac{1}{(s-3)}$ (c) $\frac{e^{3s}}{s}$ (d) $\frac{e^{-3s}}{s}$
- (vi) A network has 8 branches and 5 nodes. The number of tie-set in the network would be
(a) 6 (b) 5 (c) 4 (d) 3.
- (vii) The tie-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.
- (viii) A two-port network is reciprocal if and only if
(a) $Z_{11} = Z_{22}$ (b) $BC - AD = -1$
(c) $Y_{12} = -Y_{21}$ (d) $h_{12} = h_{21}$
- (ix) The dc gain of a system having transfer function $H(s) = \frac{18}{(s+2)(s+3)}$ is
(a) 18 (b) 6 (c) 3 (d) 2.

- (x) '. TRAN' statement in SPICE is use to analyze the network in
 (a) frequency domain (b) time domain
 (c) both frequency and time domain (d) Laplace domain.

Group - B

2. (a) Find the mesh currents i_1 , i_2 and i_3 for the network of Fig.1.

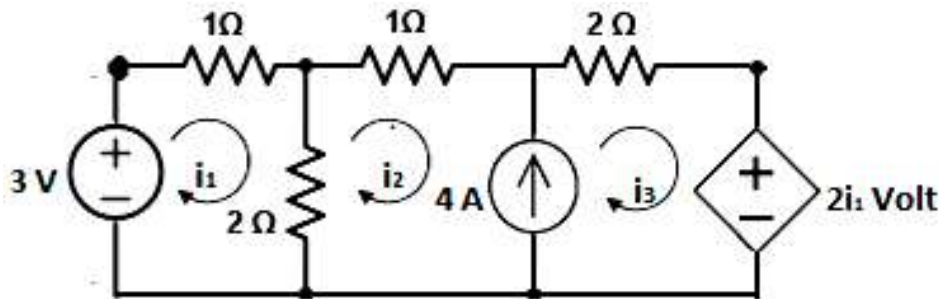


Fig.1

- (b) For the network shown in Fig.2, find the Thevenin's equivalent circuit across the terminal AB.

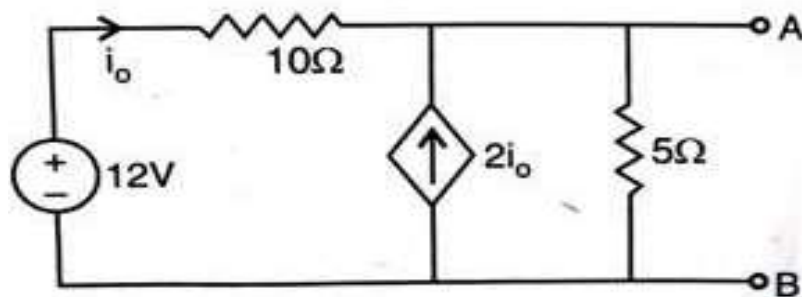


Fig.2

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 $L_{eq} = \frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M}$

- (b) Find the conductively coupled equivalent circuit for the magnetically coupled circuit of Fig.3.

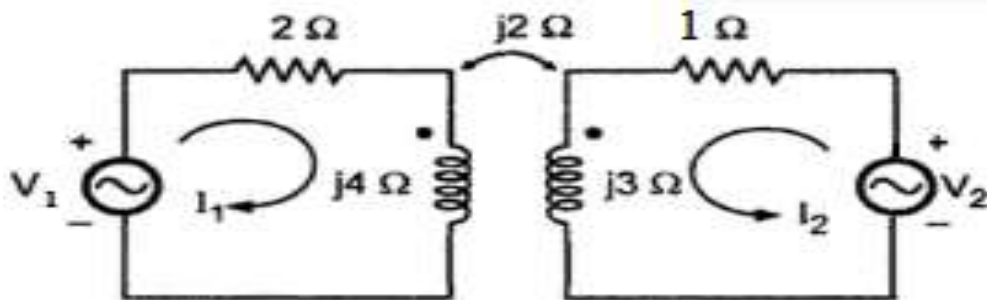
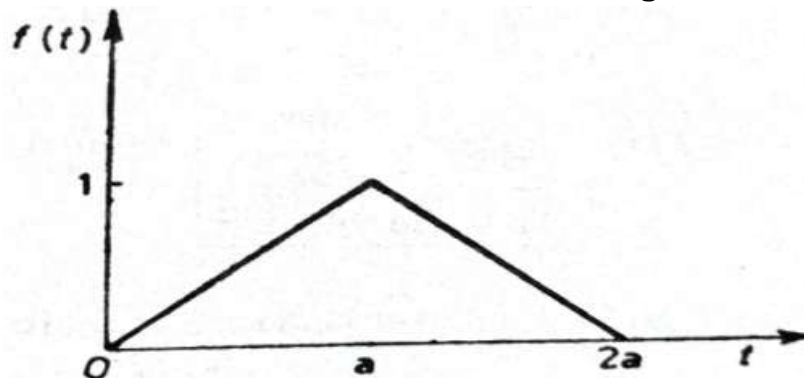


Fig.3

6 + 6 = 12

Group – C

4. (a) Define unit ramp function and find its Laplace transform.
 (b) Find the Laplace transform of the waveform shown in Fig.4.

**Fig.4**

$$(2 + 2) + 8 = 12$$

5. (a) Find Laplace inverse of $F(s) = \frac{1}{s(s^2-25)}$.
 (b) An initially relaxed series RLC circuit with $R = 5\Omega$, $L = 1H$ and $C = 1F$ is excited with a 10V, DC source. Find the expression of current, voltage across inductor and voltage across capacitor.

$$5 + (3 + 2 + 2) = 12$$

Group – D

6. (a) State the properties of Circuits and Trees.
 (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 fundamental cut-set matrix.

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

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

7. (a) Define Y-parameters. Express Y-parameters in terms of hybrid and transmission parameters.
 (b) In a two-port network, $Z_{11}=12\Omega$, $Z_{12}=Z_{21}=6\Omega$ and $Z_{22}=10\Omega$. Determine (i) Y-parameters and (iii) ABCD parameters of the network.

$$(2 + 2 + 2) + 6 = 12$$

Group – E

8. (a) Draw and explain the gain vs. frequency characteristics of low pass and high pass filters.
- (b) Design a 2nd order Butterworth high pass filter of cut off frequency 10kHz. Sketch its frequency response.

4 + (6 + 2) = 12

9. (a) Explain ‘.OP’ and ‘.AC’ statements in SPICE with examples.
- (b) A series RLC circuit with $R=10\Omega$, $L=0.1H$ and $C=0.1F$ is excited with a 1V, DC source. Write a SPICE program to plot the voltage across resistor (V_R), voltage across inductor (V_L) and voltage across capacitor (V_C).

(2 + 2) + 8 = 12

Department & Section	Submission Link
EE	https://classroom.google.com/c/MjQ4NTI4MDE2NjE4/a/Mjc0MDY2MjM3Mjc5/details