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) 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

(ii) If the number of branches in a network is 'B', the number of nodes is 'N' then the number of meshequations will be
(a) B+N (b) B+N+1 (c) B-N+1 (d) B-N

(iii) An RC series circuit has R = 10Ω and C = 0.5F. Time constant of the circuit is
(a) 1s (b) 5s (c) 0.2s (d) 20s

(iv) The Laplace transform of u(t-2) is :
$(a)\frac{1}{(s+2)}$ $(b)\frac{1}{(s-2)}$ $(c)\ \frac{e^{2s}}{s}$ $(d)\frac{e^{-2s}}{s}$

(v) Integration of impulse signal gives
(a) step signal (b) ramp signal
(c) sinusoidal signal (d) parabolic signal

(vi) The Tie-set matrix gives the relation between
(a) branch voltages and branch currents
(b) branch voltages and twig branch voltages
(c) branch currents and loop currents
(d) loop currents and branch voltages

(vii) The condition of reciprocity for ABCD-parameters is
(a) $A = D$ (b) $AD - BC = 1$
(c) $AD - BC = -1$ (d) $B = C$

(viii) Two 'two-port' networks are connected in cascade. The combination is to be represented as a single two -port network
(a) by multiplying individual ABCD parameter matrices
(b) by dividing individual ABCD parameter matrices
(c) by adding individual ABCD parameter matrices
(d) by subtracting individual ABCD parameter matrices

(ix) The transfer function $T(s) = \frac{s^2}{s^2 + as + b}$ belongs to an active
(a) low pass filter (b) high pass filter
(c) band pass filter (d) band reject filter

(x) The low frequency gain of a filter having transfer function $H(s) = \frac{4}{s^2+2s+2}$ is
(a) 4 (b) 1 (c) 3 (d)2

Group–B

2. (a) Determine the values of v_0 and i_0 for the network given in fig. 2(a). [(CO1)(Evaluating/HOCQ)]

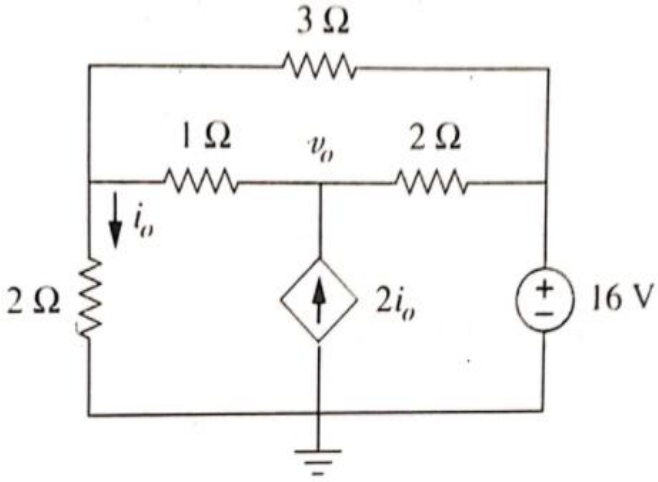

Fig. 2(a)

(b) Make use of superposition theorem to solve i_0 for the network given in fig. 2(b). [(CO1) (Applying/IOCQ)]

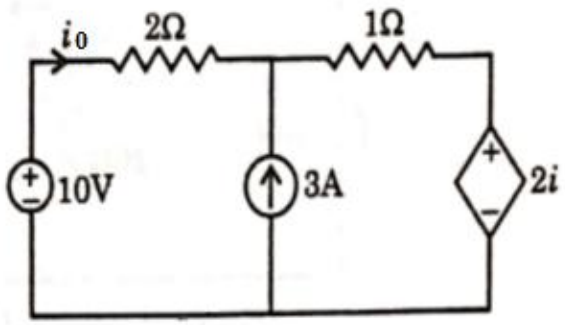

Fig. 2(b)

6 + 6 = 12

3. (a) Select the value of R_L to be connected across AB in Fig. 3(a), for maximum power transfer. Also calculate the maximum power absorbed by the R_L.
[(CO1) (Applying /IOCQ)]

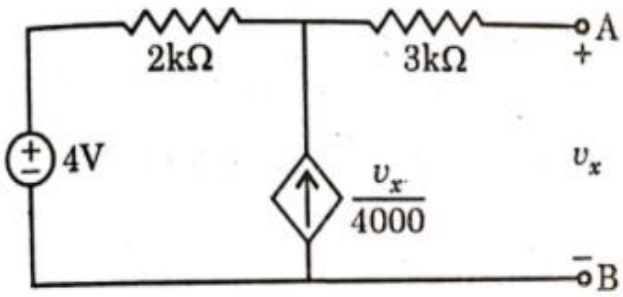

Fig. 3(a)

(b) Determine the value of I_1 and I_2 in the magnetically coupled circuit of Fig. 3(b).
[(CO2) (Evaluate /HOCQ)]

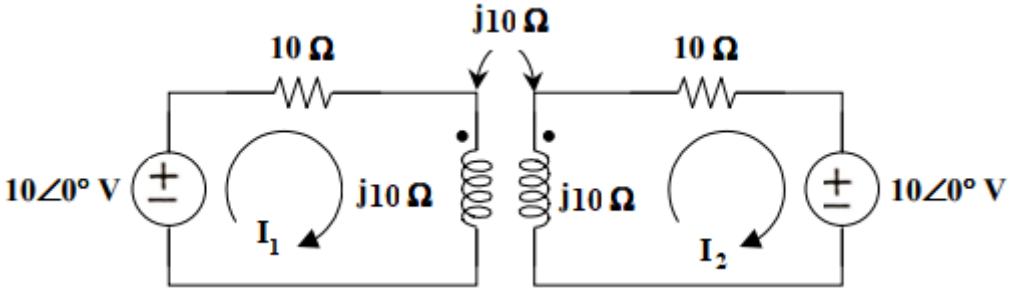

Fig. 3(b)

6 + 6 =12

Group - C

4. (a) Find the expression of current through the capacitor in an R-C series circuit if a dc voltage of V volt isapplied at $t = 0$ to the circuit. Assume there is no initial charge stored in the capacitor.What is the final voltage across the capacitor?
[(CO3) (Remember/LOCQ)]

(b) In the network shown in Fig. 4(b), the switch 'K' is closed and a steady state is reached in the network.
At time $t = 0$, the switch is opened. Determine the expression for current through the inductor, $i(t)$ for $t > 0$.[(CO3) (Evaluate/HOCQ)]

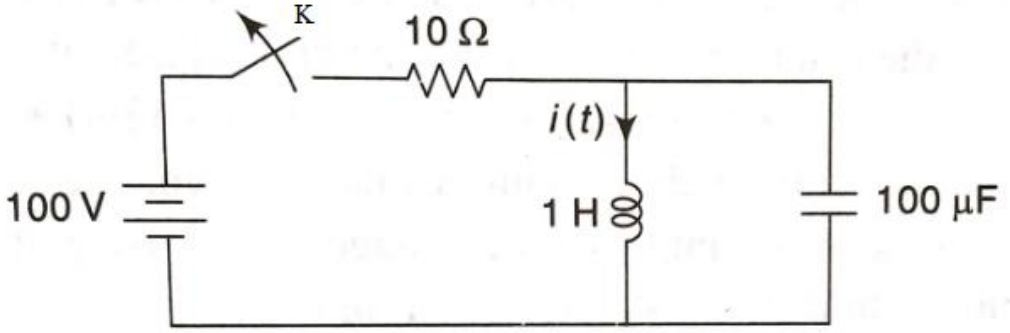

Fig. 4(b)

(4 + 1) + 7 = 12

5. (a) Determine the Laplace transform of the saw-tooth waveform given in Fig. 5(a) [(CO3) (Evaluating /HOCQ)]

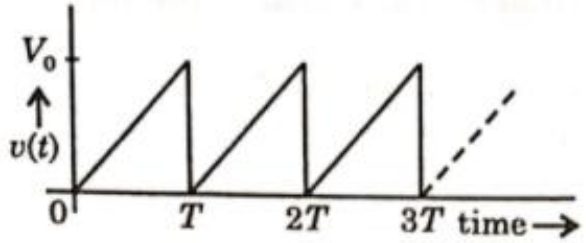

Fig. 5(a)

(b) Develop the expression of $i(t)$ in the circuit of Fig. 5(b) after closing the switch 'S' at t=0. The inductor is initially de-energised. [(CO3)(Analyze/IOCQ)]

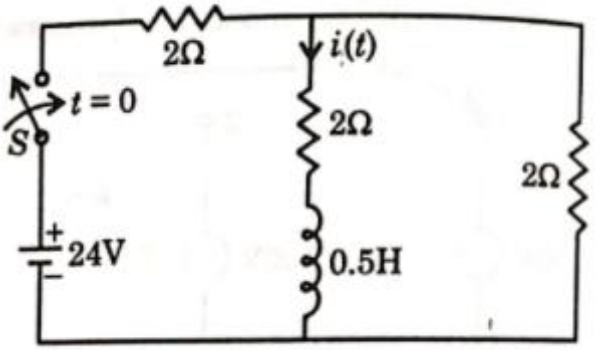

Fig. 5(b)

(c) Find the initial value and final value of a function $f(t)$ for which the Laplace transform is $V(s) = \frac{(s+2)}{s(s+1)}$. [(CO3) (Remember/LOCQ)]

4 + 6 + 2 = 12

Group - D

6. (a) State the properties of Complete Incidence matrix. [(CO4) (Remember/LOCQ)]

(b) Develop Complete Incidence matrix, fundamental Cut-set matrix and Tie-set matrix of the directed graph shown in Fig. 6(b). [(CO4) (Applying /IOCQ)]

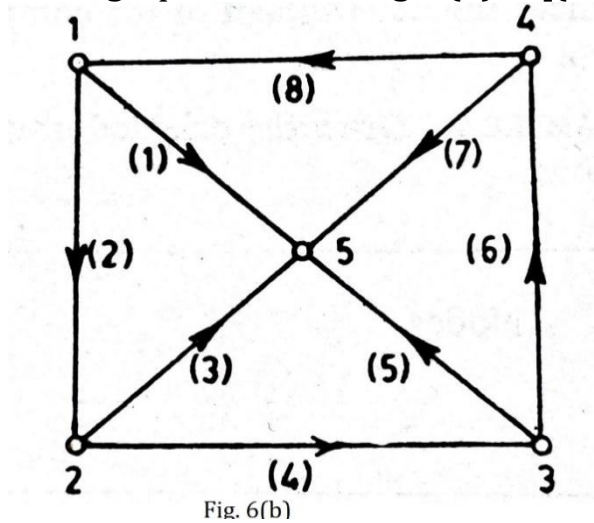

Fig. 6(b)

4 + (3 + 3 + 2) = 12

7. (a) Define Z-parameters. Express Z-parameters in terms of Y- parameters and Transmissionparameters. [(CO5)(Remember/LOCQ)]

   (b) Analyse the circuit shown in Fig. 7(b) and find its Z-parameters and Y-parameters. [(CO5) (Analyse/IOCQ)]

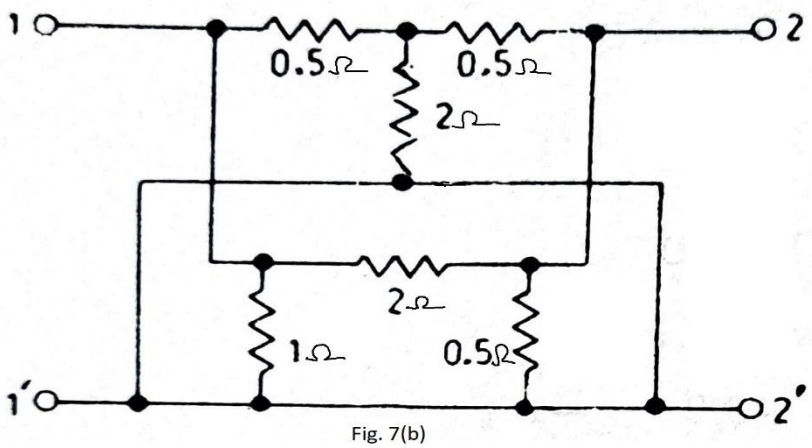

Fig. 7(b)

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

Group – E

8. (a) What is filter? State the difference between (i) active and passive filters, (ii) analog and digital filters. [(CO6)(Remember/LOCQ)]

   (b) Sketch the circuit diagram of a notch filter. Examine that, its transfer function is

$$H(s) = \frac{(s^2 + {\omega_0}^2)}{s^2 + 4\omega_0 s + {\omega_0}^2}$$

where ω_0 is the centre frequency of the notch filter. Sketch the gain vs frequency response of the filter. [(CO6) (Analyse /IOCQ)]

(2 + 1 + 1) + (1 + 6 + 1) = 12

9. (a) Determine the poles of lowpass Butterworth filter for N=4 where N is the order of the filter. Sketchthe location of poles on s-plane and hence determine the normalized transfer function of the filter. [(CO6)(Evaluate /HOCQ)]

   (b) Prove that, if $\alpha_p dB$ and $\alpha_s dB$ is the pass band and stop band attenuation of a Butterworth filter atfrequency$\omega_p$and $\omega_s$respectively, then its order is given by

$$N \geq \frac{log_{10}\sqrt{\frac{10^{0.1\alpha_p}-1}{10^{0.1\alpha_s}-1}}}{log_{10}(\frac{\omega_p}{\omega_s})}$$

[(CO6) (Evaluate /HOCQ)]

(4 + 4) + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	19.79%	43.75%	36.46%

Course Outcome (CO):

After the completion of the course students will be able to

CO1: apply network theorems to solve electrical circuits having both dependent and independent sources.

CO2: analyze magnetically coupled circuits.

CO3: apply Laplace transform technique in solving transient problems of electrical circuits.

CO4: apply the concept of graph theory to electrical circuits.

CO5: obtain the equivalent representation of electrical circuits using two- port parameter representation.

CO6: analyze and synthesize filters.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
EE	https://classroom.google.com/c/MzQ1Njk1MzIxNTY5/a/NDY2ODIwNjE3MDgw/details