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.

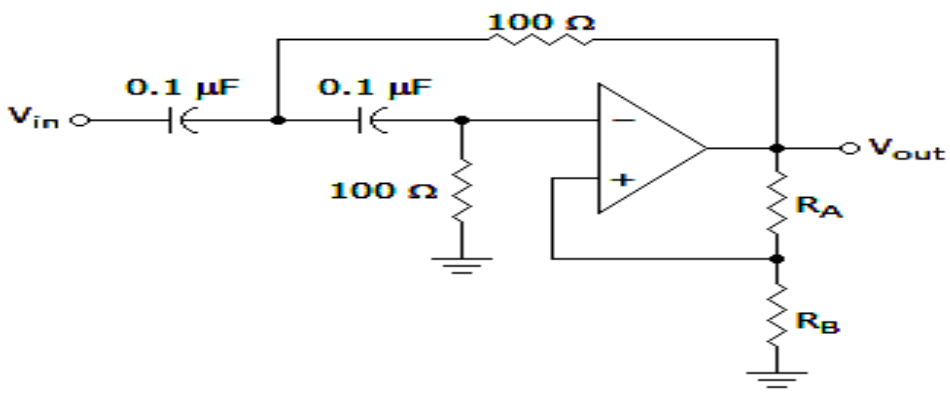
Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

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

(i) The critical frequency is the frequency at which the response drops from the passband by
(a) 20 dB (b) 3 dB (c) 6 dB (d) 40 dB

(ii) Refer to the given figure. This circuit is known as a _____ filter, and the fc is _____.
(a) high-pass, 1.59 kHz
(b) high-pass, 15.9 kHz
(c) low-pass, 15.9 kHz
(d) band-pass, 15.9 kHz



(iii) For super node analysis technique we apply
(a) KVL only (b) KCL only
(c) both KVL and KCL (d) source transformation only.

(iv) 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.

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

(vi) For $F(s) = \frac{(s+2)}{s(s+1)}$, the initial value of *f(t)* will be
(a) 0 (b) 1 (c) 2 (d) ∞.

(vii) Laplace transform of unitstep signal is
(a) 0 (b) 1 (c) $^1/_s$ (d) $^1/_{s^2}$.

(viii) If a graph has n number of nodes and b number of branches then the number of fundamental cut-set of the graph is equal to
(a) $b - n$ (b) $b + n + 1$ (c) $b - n + 1$ (d) $n - 1$.

(ix) The condition of symmetry for h-parameters is

(a) $h_{11}=h_{22}$ (b) $h_{12}= -h_{21}$ (c) $h_{11}\,h_{22}- h_{12}\,h_{21} =1$ (d) $h_{12}= h_{21}$

(x) Two 'two-port' networks are connected in series. The combination is to be represented as a single two -port network

(a) by adding individual Z parameter matrices

(b) by multiplying individual Z parameter matrices

(c) by subtracting individual Z parameter matrices

(d) by dividing individual Z parameter matrices.

Group – B

2. (a) Solve for the mesh currents i_1 and i_2 for the network given in Fig. 2(a). [(CO1)(Apply/IOCQ)]

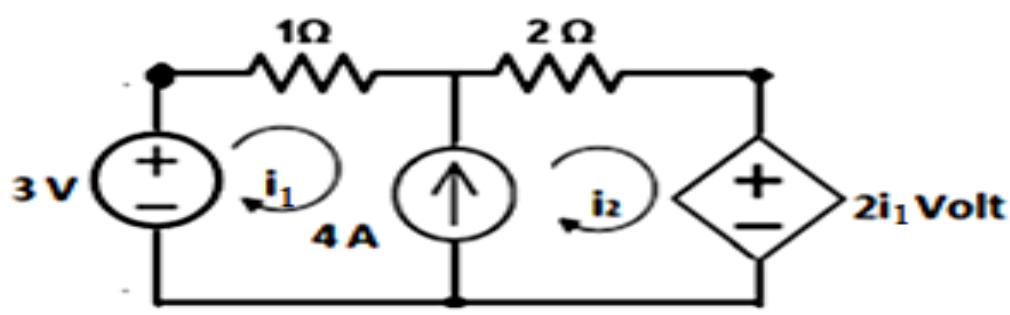


Fig. 2(a)

(b) For the circuit of Fig. 2(b), solve for the value of current passing through load resistance R_L using Thevenin's theorem. [(CO1)(Apply/IOCQ)]

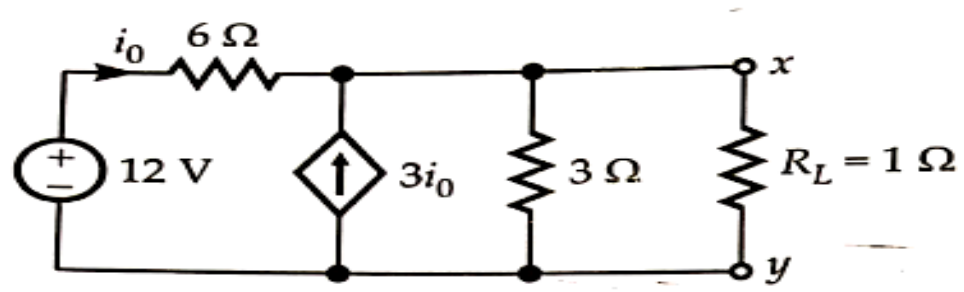


Fig. 2(b)

5 + 7= 12

3. (a) Make use of superposition theorem to solve i and i_0 for the network given in Fig.3(a). [(CO1)(Apply/IOCQ)]

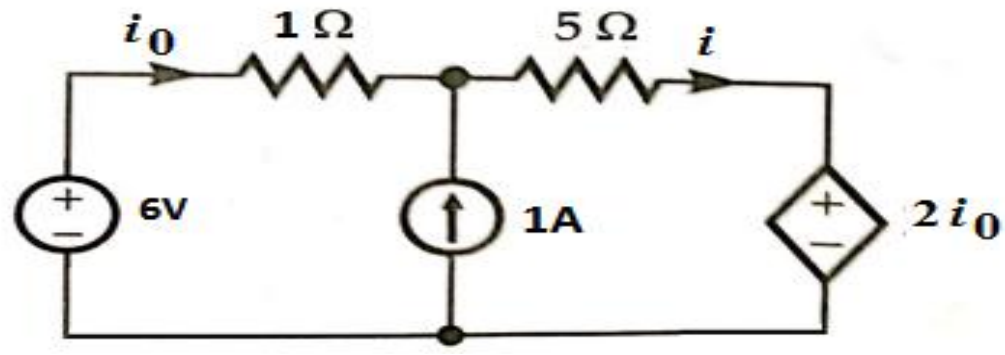


Fig. 3(a)

(b) Construct the dotted equivalent circuit and determine the total inductance of the three series connected coupled coils as shown in Fig. 3(b). [(CO2)(Apply/IOCQ)]

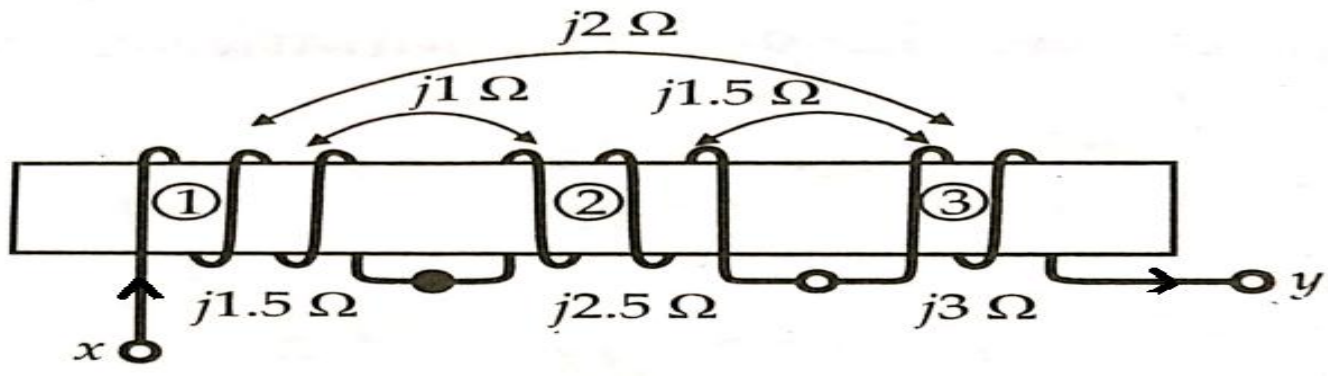


Fig. 3(b)

7 + 5 = 12

Group – C

4. (a) Define unit Step signal. [(CO3)(Remember/LOCQ)]

(b) Determine Laplace transform of the waveform shown in fig. 4(b). [(CO3)(Evaluate/HOCQ)]

Fig. 4(b)

(c) In the circuit shown in Fig. 4(c), the switch 'K' is at position 1 for a long time. Develop the expression for the current through the inductor when the switch is moved from position 1 to 2 at t=0. [(CO3)(Apply/IOCQ)]

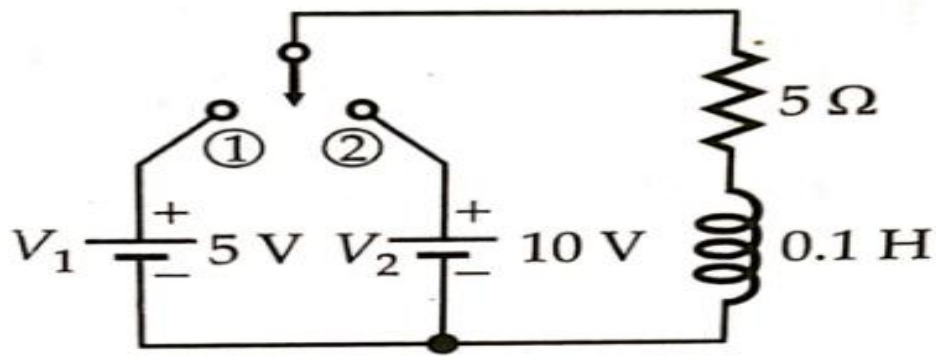


Fig. 4(c)

2 + 4 + 6 = 12

5. (a) Determine the signal x(t), whose first derivative is as shown in fig.5(a). [(CO3)(Evaluating/HOCQ)]

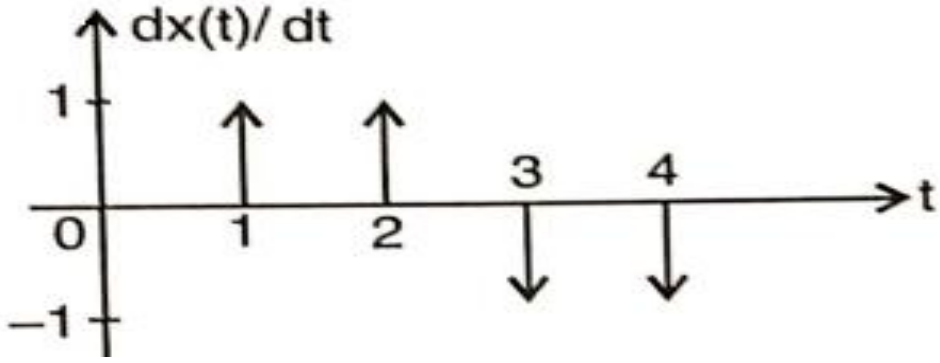


Fig. 5(a)

(b) In the series R-L-C circuit shown in fig. 5(b), there is no initial charge on the capacitor. If the switch 'S' is closed at t = 0, solve for the resulting current for $t > 0$. What will be the final current flowing through the circuit? Also state the nature of response. [(CO3)(Apply/IOCQ)]

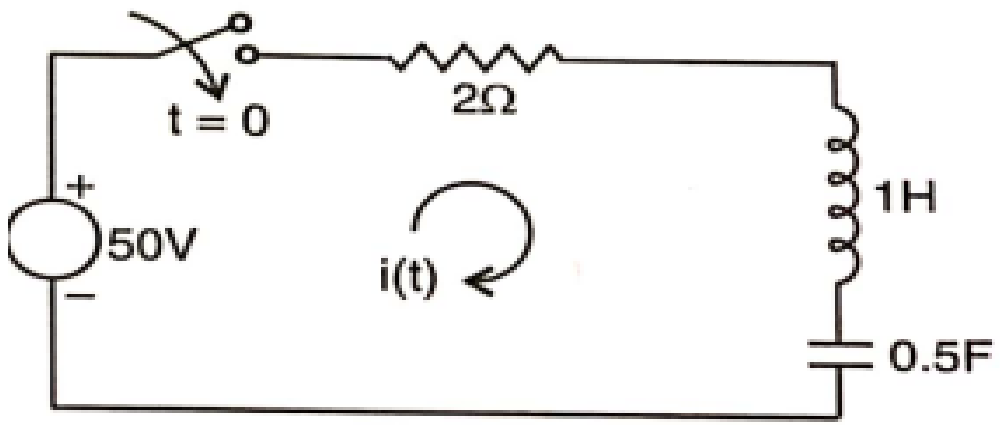


Fig. 5(b)

(c) Define unit Ramp signal. What is its Laplace transform? [(CO3)(Remember/LOCQ)]

4 + 6 + 2 = 12

Group – D

6. (a) What is co-tree of a graph ? [(CO4)(Remember/LOCQ)]
   (b) (i) Develop Complete Incidence matrix of the directed graph shown in Fig. 6(b(i)).
   (ii) Assume the sub-graph shown in Fig. 6(b(ii)) as a tree and develop fundamental Cut-set matrix and Tie-set matrix. [(CO4)(Apply/IOCQ)]

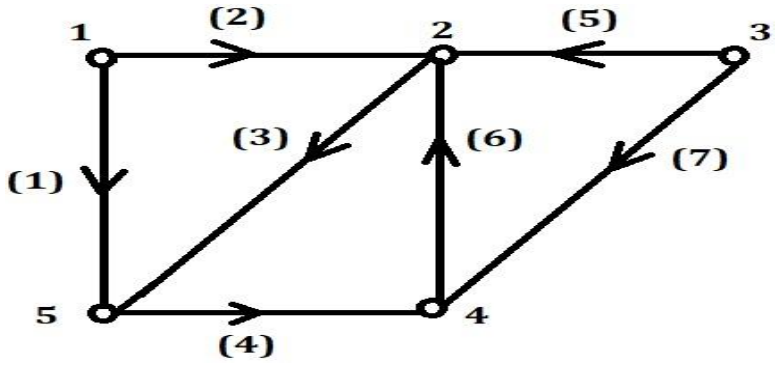


Fig. 6 (b(i))

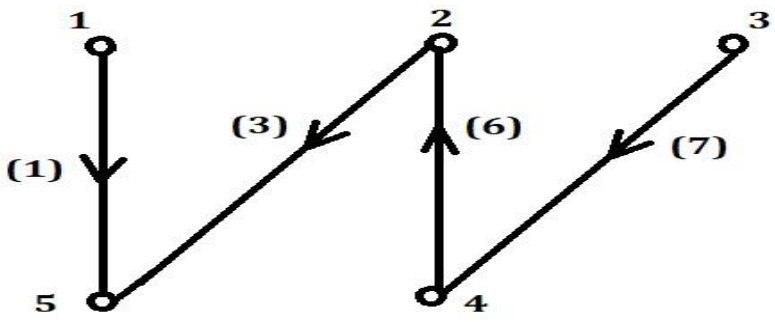


Fig. 6 (b(ii))

(c) Prove that, in graph theory, the relation between branch voltage and node voltage is $V_b = A^T V_n$, where A = Reduced Incidence Matrix , V_b = branch voltage matrix and V_n = node voltage matrix. [(CO4) (Evaluate/HOCQ)]

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

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

(b) For transmission parameter, develop the condition of reciprocity. [(CO5)(Create/HOCQ)]

(c) Analyse the circuit shown in Fig.7(c) and find ABCD parameters. [(CO5)(Analyze/IOCQ)]

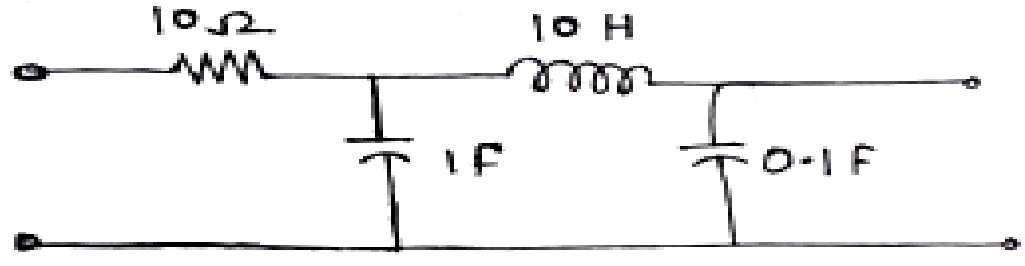


Fig. 7(c)

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

Group – E

8. (a) Define Filter. [(CO6)(Remember/LOCQ)]

(b) Show the derivation of the transfer function of a 2nd order active Sallen & Key Low Pass Filter. [(CO6)(Understand/LOCQ)]

(c) Design a 2nd order Butterworth low pass filter of cut-off frequency 2 kHz. [(CO6)(Create/HOCQ)]

2 + 5 + 5 = 12

9. (a) Draw the circuit diagram of a Narrow Band Pass Filter. [(CO5)(Remember/LOCQ)]

(b) Derive the transfer function of a Notch Filter along with its Gain vs Frequency response. [(CO5)(Analyse/IOCQ)]

(c) Determine the poles of lowpass Butterworth filter for N=4, where N is the order of the filter along with their location of poles on s-plane. [(CO6)(Evaluate/HOCQ)]

3 + 6 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	19.79	59.38	20.83

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.