

CIRCUIT THEORY
(ELE2101)

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.*

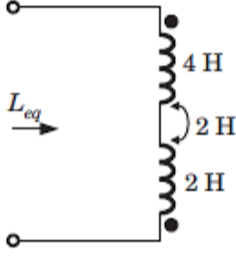
Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) For super mesh analysis we apply
(a) KVL only (b) KCL only
(c) both KVL and KCL (d) Lenz's Law
- (ii) Superposition theorem is not applicable for
(a) voltage calculations (b) current calculations
(c) power calculations (d) circuit containing more than two independent sources
- (iii) L_{eq} for the given circuit is
(a) 2H (b) 4H
(c) 6H (d) 8H
- 
- (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) Double derivative of unit ramp signal is
(a) unit impulse signal (b) unit step signal
(c) unit parabolic signal (d) sinusoidal signal
- (vi) A coil with a certain number of turns has a specified time constant. If the number of turns is doubled, its time constant would
(a) remain unaffected (b) become doubled
(c) get halved (d) become four-fold
- (vii) If a graph has "b" number of branches and "n" number of nodes then the number of tie-set of the graph are
(a) $(b - n + 1)$ (b) $(b + n - 1)$
(c) $(b + n + 1)$ (d) $(b - n - 1)$
- (viii) Input driving point impedance (when output side of a two port network is kept open) is:
(a) Z_{11} (b) Z_{12}
(c) Z_{21} (d) Z_{22}
- (ix) As quality factor increases bandwidth of a filter circuit is
(a) Increases (b) Decreases
(c) Remains same (d) no relationship exists between bandwidth and quality factor
- (x) The transfer function of a normalised 2nd order Butterworth low pass filter is
(a) $1/(s + 1)$ (b) $s/(s + 1)$
(c) $1/(s^2 + \sqrt{2}s + 1)$ (d) $s^2/(s^2 + \sqrt{2}s + 1)$

Fill in the blanks with the correct word

- (xi) If source impedance is complex, then maximum power transfer occurs when the load impedance is _____ of the source impedance.
- (xii) The dual of Norton's theorem is _____ theorem.
- (xiii) During steady-state condition capacitor behaves as _____ circuit.
- (xiv) The relation between branch current matrix and loop current matrix is _____.
- (xv) The transfer function of 2nd order high pass filter of cut off frequency 10rad/sec is _____.

Group - B

2. (a) Calculate v_0 and i_0 for the circuit of Fig. 1.

[[CO1](Analyse/HOCQ)]

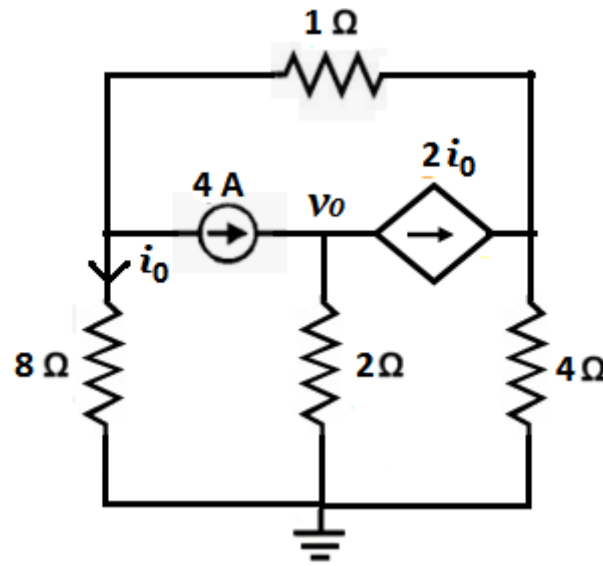


Fig. 1

- (b) Calculate current through 9 Ω resistance in circuit of Fig. 2 using Thevenin's theorem.

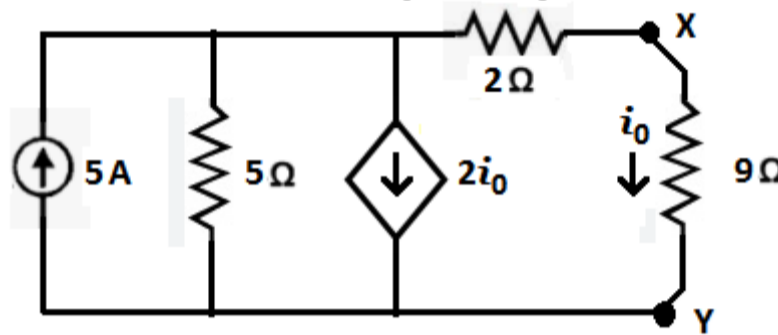


Fig. 2

[[CO1](Apply/IOCQ)]

6 + 6 = 12

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

[[CO2](Apply/IOCQ)]

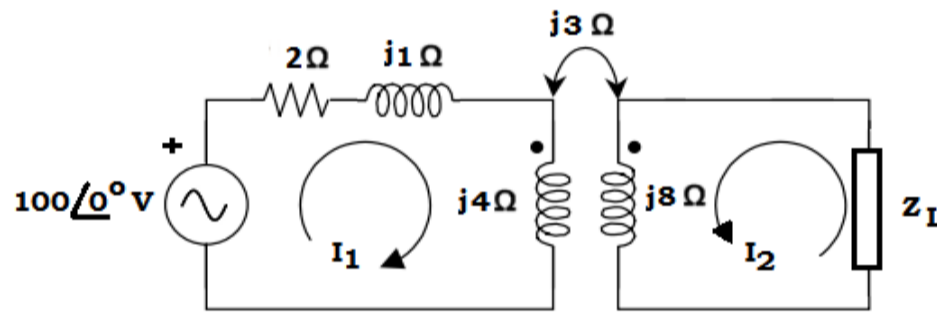


Fig. 3

- (b) Calculate node voltages of the circuit of Fig. 4.

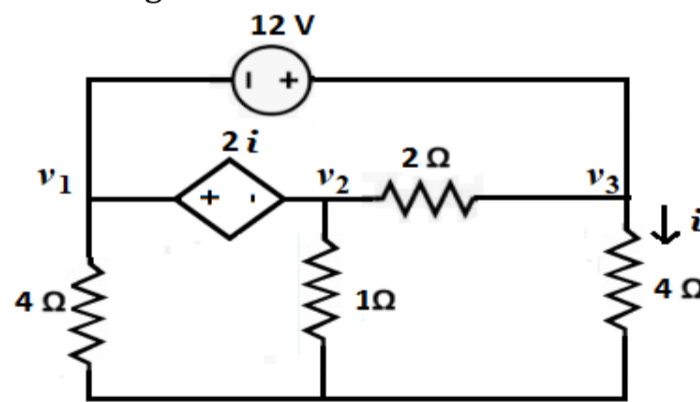


Fig. 4

[[CO1](Apply/IOCQ)]

6 + 6 = 12

Group - C

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

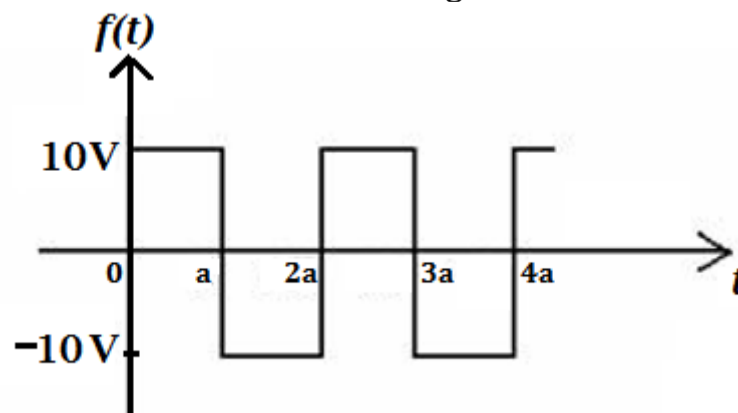


Fig. 5

[[CO3](Analyse/HOCQ)]

- (b) Develop the expression of $i(t)$ in the circuit of Fig. 6 after closing the switch 'S' at $t=0$. The inductor is initially de-energised.

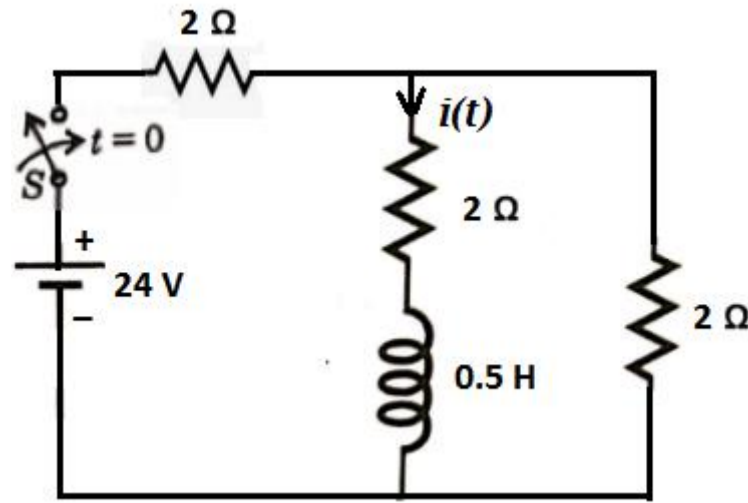


Fig. 6

[[CO3](Apply/IOCQ)]
6 + 6 = 12

5. (a) Determine Laplace transform for the staircase waveform as shown in Fig. 7.

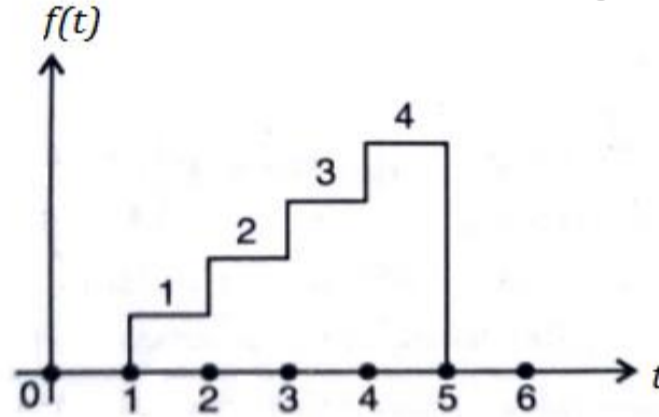


Fig. 7

[[CO3](Apply/IOCQ)]

- (b) In the circuit shown in Fig. 8, the switch 'S' is closed at $t=0$. Develop the expression of voltage across the capacitor for $t > 0$ assuming zero initial voltage across the capacitor.

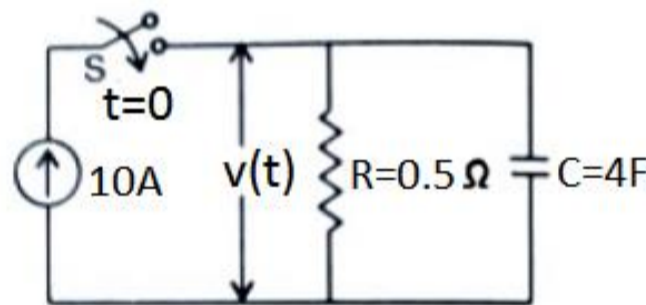


Fig. 8

- (c) Define unit ramp signal. Draw its waveform.

[[CO3](Apply/IOCQ)]
[[CO3](Understand/LOCQ)]
4 + 6 + 2 = 12

Group - D

6. (a) Develop Complete Incidence matrix of the directed graph shown in Fig.9.
(b) Assume the sub-graph shown in Fig. 10 as a tree and develop fundamental Cut-set matrix and Tie-set matrix.

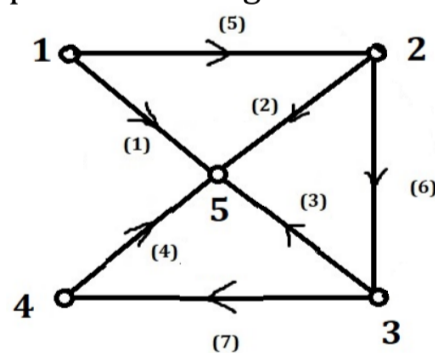


Fig. 9

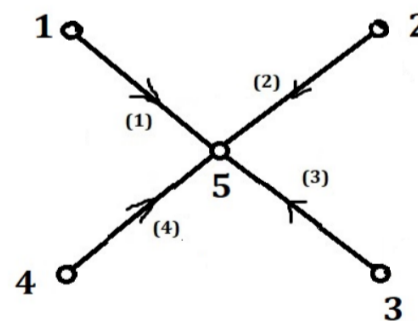


Fig.10

[[CO4] (Apply/IOCQ)]
4 + (4 + 4) = 12

7. (a) Analyse the circuit shown in Fig. 11 and find Z parameters.

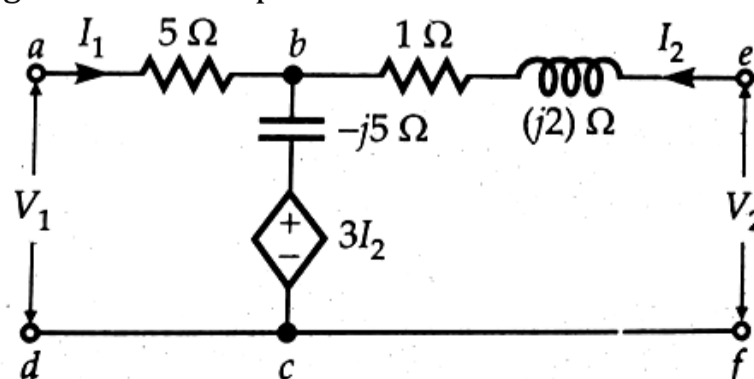


Fig. 11

[[CO5](Analyse/IOCQ)]

- (b) For Y parameters, develop the condition of Symmetry.
 (c) Define ABCD parameters. Express Y- parameters in terms of Z parameters.

[[CO5](Create/HOCQ)]
 [[CO5](Remember/LOCQ)]
6 + 3 + (1 + 2) = 12

Group - E

8. (a) Draw the neat circuit diagram of a notch filter and find its overall transfer function. Show that the pass band gain of the notch filter at the centre frequency is zero.
 (b) Design a notch filter with centre frequency of 60Hz.

[[CO6](Apply/IOCQ)]
 [[CO6](Create/HOCQ)]
(1 + 6 + 2) + 3 = 12

9. (a) Show that, if $\alpha_p dB$ and $\alpha_s dB$ is the pass band and stop band attenuation of a Butterworth filter at frequency ω_p and ω_s respectively, then its order is given by

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

- (b) Determine the poles of 2nd order Butterworth filter. Sketch the location of poles on s-plane and hence determine the normalized transfer function of the low pass filter.

[[CO6](Analyse/IOCQ)]
 [[CO6](Apply/IOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	5.21	71.87	22.92