2011

CIRCUIT THEORY & NETWORKS

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) For N no. of modes and B no. of branches of a graph the rank is

a) $N - B + 1$ b) $N + B + 1$

c) $N + 1$ d) $N - 1$.

ii) Laplace transform analysis gives

a) time domain response

b) frequency domain response

c) both (a) and (b)

d) none of these.

iii) What should be the internat resistance of the ideal current source ?

a) 0 b) ∞

c) both (a) and (b) d) none of these.

iv) Superposition theorem is not applicable to networks having

a) transformers

b) dependent voltage sources

c) non-linear elements

d) dependent current sources.

v) For a series resonant R-L-C circuit the power factor of the circuit is

a) 1 b) 0·5

c) 0 d) infinity.

vi) The passive element among the following is :

a) voltage source b) current source

c) transistor d) inductor.

vii) The current through a pure capacitor

a) lags the voltage

b) leads the voltage

c) in phase with voltage

d) phase depends on initial circuit condition.

viii) Condition for reciprocity of y-parameter is

a) $y_{11} = y_{12}$ b) $y_{12} = y_{21}$

c) $y_{11} = y_{22}$ d) $y_{22} = y_{21}$.

ix) Initial value theorem states that

a) $\lim_{s \to 0} F(s) = f(0)$ b) $\lim_{s \to 0} SF(s) = f(0)$

c) $\lim_{s \to \infty} F(s) = f(0)$ d) $\lim_{s \to \infty} SF(s) = f(0)$.

x) A dc voltage V is applied to a series R-L circuit. The steady state current is

a) $\frac{V}{R^2 + L^2}$ b) $\frac{V}{L}$

c) 0 d) $\frac{V}{R}$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. Explain under what condition, an RC circuit behaves as

a) integrator b) differentiator.

3. State and prove maximum power transfer theorem.

4. A shifted unit step function is expressed as $f(t) = u(t - a)$. Obtain its Laplace Transform.

5. For a two port network, show that AD – BC = 1.

6. Draw the oriented graph of the network in the following figure (Fig. 1) and find the complete incidence matrix.

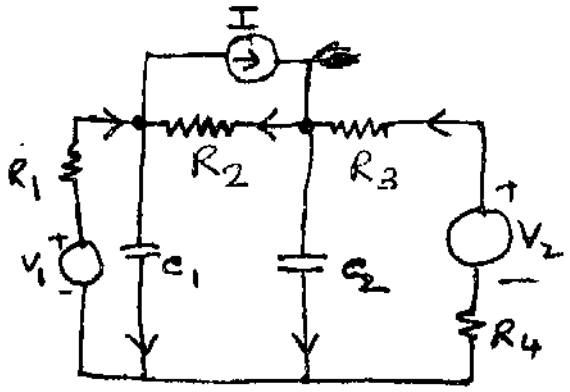

Fig. 1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Explain series and parallel resonance with necessary circuits.

   b) Show that for an RLC series circuit the resonance frequency $\omega r = \sqrt{\omega_1 \omega_2}$, where ω_1 and ω_2 are the half power frequencies.

   c) A coil is at resonance at 10 kHz with a capacitor. If the resistance and inductance of the coil are 200 Ω and 5 H, find Q-factor of the coil. 5 + 5 + 5

8. a) Find the total inductance of the three series connected coupled circuits. (Fig. 2)

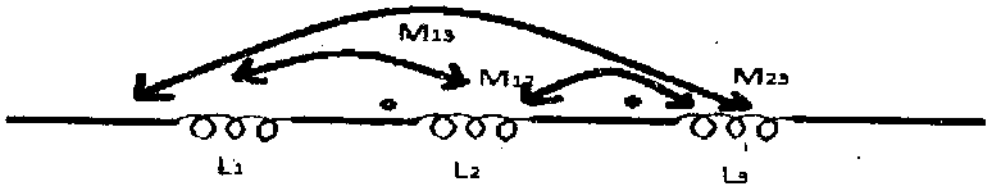

Fig. 2

Given, $L_1 = 1$ H; $L_2 = 2$ H; $L_3 = 5$ H

$M_{12} = 0.5$ H; $M_{23} = 1$ H, $M_{13} = 1$ H

b) In the network shown in the Fig. 3 below, find V such that the current through $(3 + j\,4)\ \Omega$ impedance is zero. Use node voltage analysis.

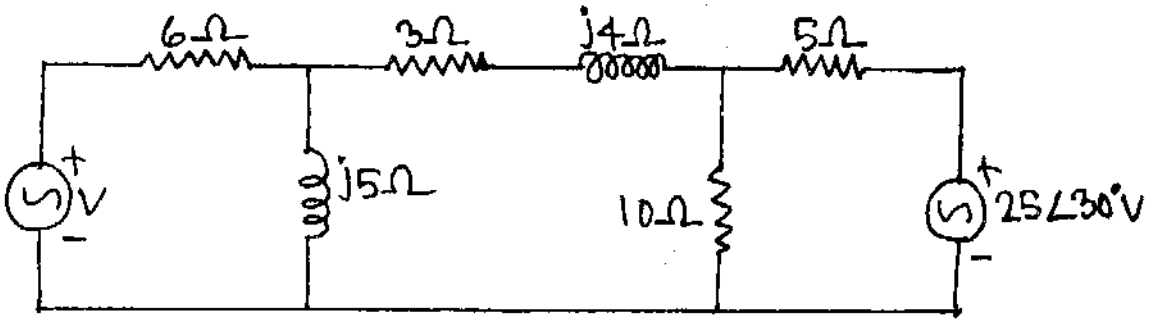

Fig. 3

c) Find the current through R_L in the circuit shown in Fig. 4 below using Norton's theorem.

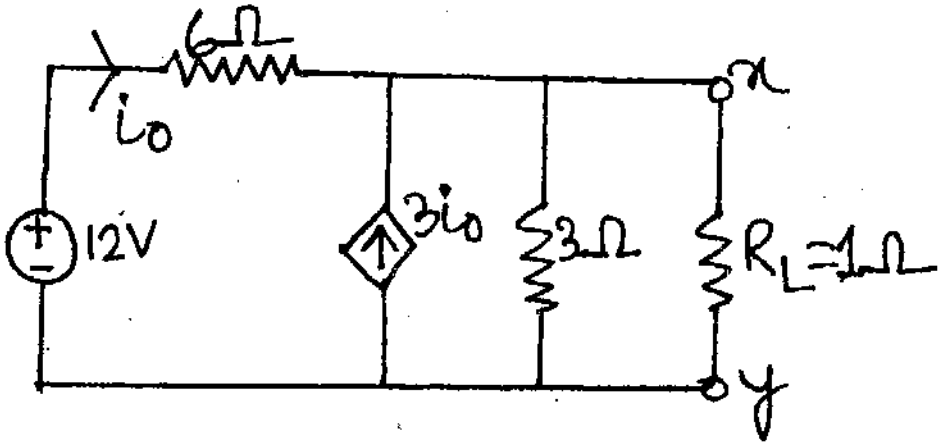

Fig. 4 5 + 5 + 5

9. a) Why are h-parameters called hybrid parameters ? Find the h-parameters from the two port network given in Fig. 5. Is the network reciprocal or symmetric ? Justify.

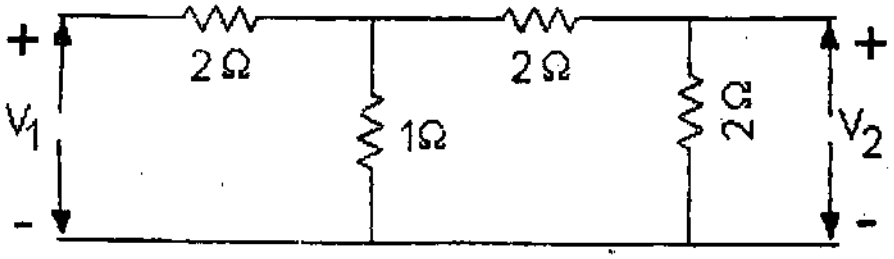

Fig. 5

b) For an RL series circuit shown below with R = 2 Ω, L = 1H and no initial current in the inductor, a voltage $V = 4e^{-t}$ V is applied at $t = 0$. Find expression for the resulting current in the circuit for $t \geq 0$ using Laplace transform method. (Fig. 6)

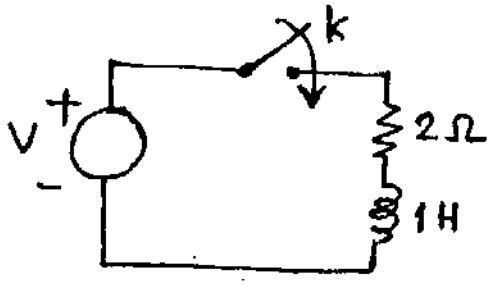

Fig. 6

c) Find the inverse Laplace transform of the function

$$V(S) = \frac{10(S+4)}{S(S+3)(S+1)^2}$$

5 + 5 + 5

10. a) State and explain superposition theorem.

b) Find the net current flowing through 10 ohm resistor applying superposition theorem. (Fig. 7)

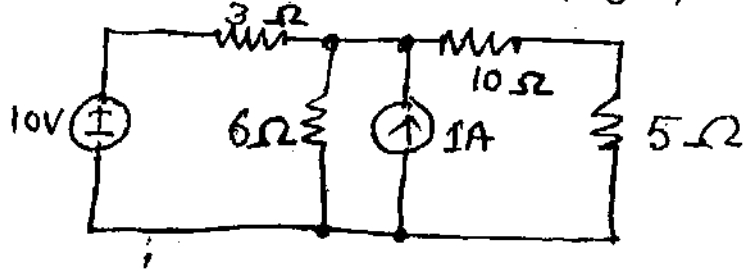

Fig. 7

c) Find the equivalent delta connection of the given network (Fig. 8)

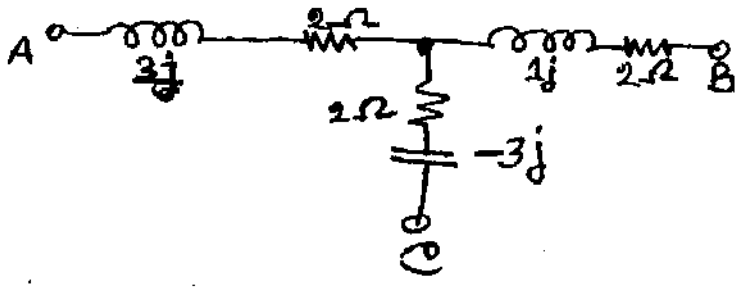

Fig. 8

5 + 5 + 5

11. Write short notes on any *three* of the following : 3×5

a) Driving point impedance

b) Compensation theorem

c) Concept of complex frequency

d) Initial value theorem and final value theorem

e) Phasor diagrams.