EC-301

CIRCUIT THEORY AND NETWORKS

Time Alloted: 3 Hours — Full Marks: 70

The questions are of equal value.
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. Answer any *ten* questions. $10 \times 1 = 10$

(i) For maximum power to be transferred between the load and the source the condition is

(A) $R_S > R_L$ (B) $R_S = R_L$ (C) $R_S < R_L$ (D) None of these

(ii) What should be the internal resistance of the ideal voltage source?

(A) 0 (B) ∞ (C) Both (A) and (B) (D) None of these

(iii) If $f(t) = te^{-2t}$, the Laplace Transform of the function is given by

(A) $\frac{4}{(s+2)^2}$ (B) $\frac{36}{(s+3)^2}$ (C) $\frac{2}{(s+2)^2}$ (D) $\frac{4}{(s+2)}$

(iv) Superposition Theorem is not applicable to networks having

(A) Transformers (B) Non-linear elements
(C) Dependent voltage sources (D) Dependent current sources

(v) A dc voltage V is applied to a series R-C circuit, the steady state current is

(A) $\frac{V}{R}e^{-t/RC}$ (B) 0 (C) ∞ (D) $\frac{V}{R}$

(vi) If $f(t)$ and its first derivative is Laplace transformable, then Final value theorem is:

(A) $\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$ (B) $\lim_{t\to\infty} f(t) = \lim_{s\to 0} F(s)$
(C) $\lim_{t\to 0} f(t) = \lim_{s\to\infty} sF(s)$ (D) None of these

(vii) The coefficient of coupling for two coils having $L_1 = 2$ H, $L_2 = 8$ H, $M = 3$ H is

(A) .1875 (B) .75 (C) 1.333 (D) 5.333

(viii) A series R-L-C circuit is over damped when

(A) $R > 2\sqrt{\frac{L}{C}}$ (B) $R < 2\sqrt{\frac{L}{C}}$ (C) $R = 2\sqrt{\frac{L}{C}}$ (D) None of these

(ix) 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) $h_{12} = h_{21}$

(x) The unit step function of the first derivative of

(A) ramp function (B) impulse function
(C) gate function (D) parabolic function

(xi) In a series RLC circuit, which of these quality factors have the steepest curve at resonance?

(A) Q = 20 (B) Q = 12 (C) Q = 8 (D) Q = 4

(xii) The graph of a network has six branches with three tree branches. The minimum number of equations required for the solution of the network is

(A) 2 (B) 3 (C) 4 (D) 5

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. $3 \times 5 = 15$

2. Calculate the node voltages in the circuit (Fig. 1) given below.

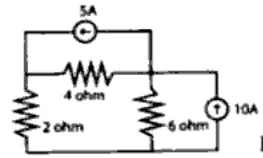

Fig. 1

3. Draw the oriented graph of the network in the following figure (Fig. 2) and obtain the tie-set matrix.

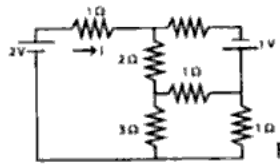

Fig. 2

4. Find $f(t)$, given that $F(s) = \frac{10s^2 + 4}{s(s+1)(s+2)^2}$

5. Prove that $AD - BC = 1$.

6. In this circuit find the reading of the voltmeter V. Interchange the current source and the voltmeter and verify the reciprocity theorem.

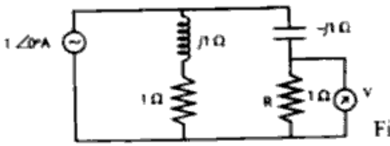

Fig. 3

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. a) Calculate the node voltages at nodes 1 and 2 in the following circuit (Fig. 4). 4

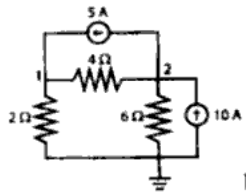

Fig. 4

b) Find the values of i_1 and i_2 in the following circuit using supermesh analysis (Fig. 5). 5

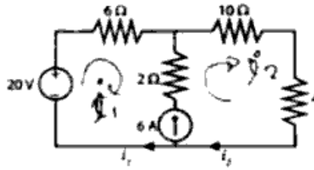

Fig. 5

c) Find the Norton's equivalent of the circuit shown below (Fig. 6) at terminals a–b. 6

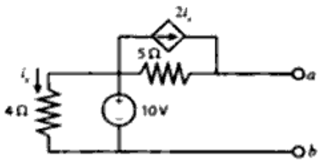

Fig. 6

8. a) State Thevenin's theorem. 2

b) Obtain the Thevenin's equivalent of the following circuit (Fig.7) at terminals a–b. 6

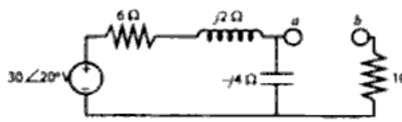

Fig. 7

c) Apply superposition theorem to find the voltage drop across 0.2 F capacitor in the circuit shown below (Fig. 8). 7

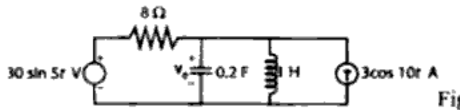

Fig. 8

9. a) Define Laplace transform. 2

b) Show that if a function $f(t)$ is piecewise continuous, then the Laplace transform of its derivative is given by $L\left[\frac{df(t)}{dt}\right] = sF(s) - f(0)$ where $F(s) = L[f(t)]$ 4

c) Find out cut-set matrix from the following graph (Fig. 9). 5

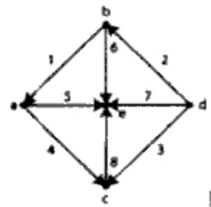

Fig. 9

d) A series RC circuit consists of a resistor of 10 Ω and a capacitor of 0.1 F. A constant voltage of 20 V is applied to the circuit at t = 0. Obtain the current equation. Determine the voltages across the resistor and the capacitor. 4

10. a) Define the ABCD parameters of a 4-terminal network. 2

b) Prove that AD – BC = 1. 4

c) Derive the symmetry condition for Z-parameters in two port network. 4

d) Determine the Z parameters of the following circuit (Fig. 10). 5

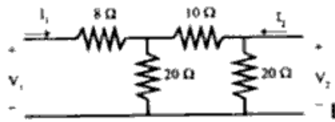

Fig. 10

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

(a) Compensation theorem
(b) Coefficient of coupling
(c) Hybrid parameters
(d) Sinusoidal response of series RL circuit.
(e) Maximum power transfer theorem for complex impedance circuits.