MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

EC-301

CIRCUIT THEORY AND NETWORKS

Time Allotted: 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.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1 Answer any *ten* questions. $10 \times 1 = 10$

(i) The Laplace transform of a shifted unit step f(t)=U(t – a) is

(A) e^{-as} (B) $e^{-as/s}$
(C) se^{-as} (D) $s(1 - e^{-as})$

(ii) A circuit having neither emf nor any energy

(A) active circuit (B) passive circuit
(C) unilateral circuit (D) bilateral circuit

(iii) The time constant of series RC circuit is

(A) RC (B) 1/RC
(C) RC/2 (D) 2RC

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(iv) A tie-set matrix has 3 rows and 7 branches. The number of twig is

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

(v) The current through a pure capacitor

(A) lags the voltage (B) leads the voltage
(C) in phase with the voltage (D) none of these

(vi) What should be the internal resistance of a ideal current source

(A) 0 (B) infinite
(C) both (A) and (B) (D) none of these

(vii) Maximum power transfer occurs at circuit efficiency of

(A) 100% (B) 50%
(C) 25% (D) 75%

(viii) The 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) The Laplace transform analysis gives

(A) time domain analysis (B) frequency domain analysis
(C) both (A) and (B) (D) real response only

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

(A) $V/(R^2 + L^2)$ (B) V/L
(C) 0 (D) V/R

(xi) The number of links for graph having n-nodes b branches is

(A) b – n + 1 (B) n – b + 1
(C) b + n – 1 (D) b + n

(xii) A step function is the first derivation of

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

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Verify the final value theorem of Laplace transform for the following function:

$$f(t) = 2 + e^{-3t}\cos 2t$$

3. The reduced incidence matrix of a network is given below:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 & 1 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \end{bmatrix}$$

Draw the graph of the network.

4. Find the resonant frequency of the circuit (Fig.1) given below.

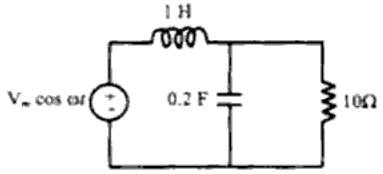

Fig. 1

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5. Apply Millman's theorem to find out the current passing through the load resistance R_L in circuit (Fig.2) shown below.

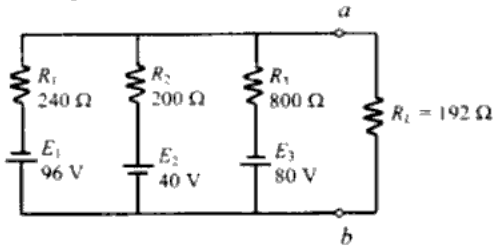

Fig. 2

6. Find the Y parameters for the following network shown in Fig.3.

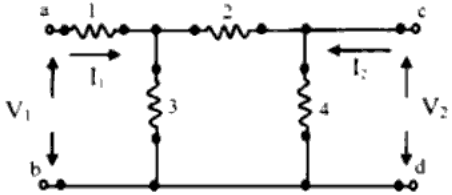

Fig. 3

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GROUP C
(Long Answer Type Questions)

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

7. (a) Use mesh analysis to find the current I_0 in the following circuit (Fig.4). 5+6+4

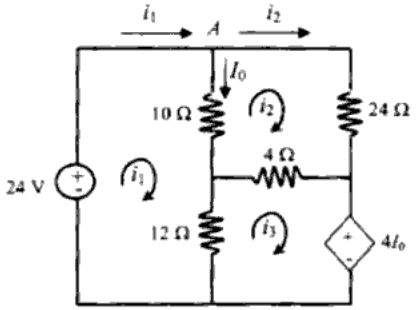

Fig. 4

(b) Find the Thevenin equivalent of the following circuit (Fig.5) at terminals a-b.

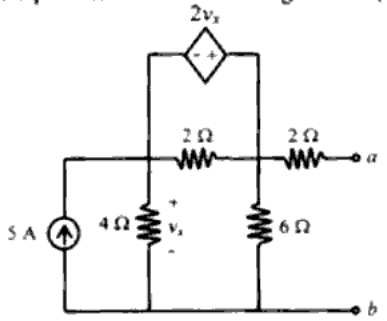

Fig. 5

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(c) State and prove maximum power transfer theorem for complex impedance circuits.

8. (a) State and explain reciprocity theorem. 3+6+6

(b) Show the applicability of reciprocity theorem in the following network (Fig.6).

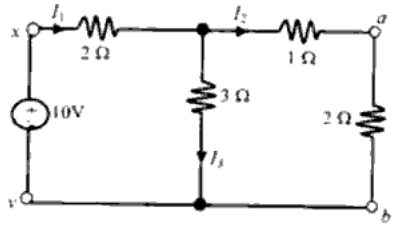

Fig. 6

(c) Determine the voltage V_0 in the following circuit (Fig.7).

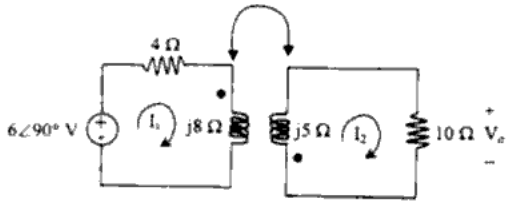

Fig. 7

9. (a) Find v_1 and v_2 using nodal analysis in the circuit shown in Fig.8. 6+3+3+3

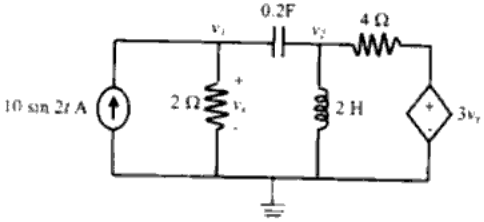

Fig. 8

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(b) What is oriented graph of a network? Explain with a suitable example.
(c) Develop at least three trees which you considered as network. Mark the twigs and links.
(d) What is co-tree? Are the branches of a co-tree always connected?

10.(a) Show that if a function $f(t)$ is continuous, then the Laplace transform of its integral $\int f(t)dt$ is 5+5+5

$$L\left[\int f(t)dt\right] = \frac{1}{s}F(s)$$

Where $F(s) = L[f(t)]$.

(b) Determine the inverse Laplace transform of the function $F(s) = \frac{s-5}{s(s+2)^2}$.

(c) Obtain the current s-domain expression for current I_L in the circuit shown in Fig.9. Also obtain the time domain expression for inductor current. The switch is opened at t = 0. Assume initial energy stored in the circuit is zero.

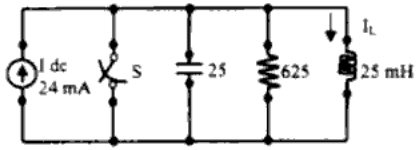

Fig. 9

11. Write short notes on any *three* of the following: 3×5
(a) Convolution and its properties
(b) Reciprocity and symmetry properties in terms of ABCD parameters
(c) Series connection of coupled inductors
(d) Cut-set matrix and KVL
(e) Step response of a series RC circuit.