Modified

CBCS SCHEME

USN

18EC32

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Network Theory

Time: 3 hrs.

Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Determine current through 12Ω resistor shown in Fig.Q1(a), using source transformation.

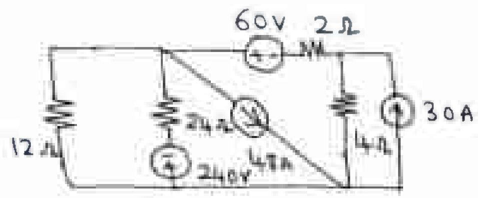

Fig.Q1(a)

(08 Marks)

b. Find the equivalent resistance of the circuit shown in Fig.Q1(b), using star delta transformation.

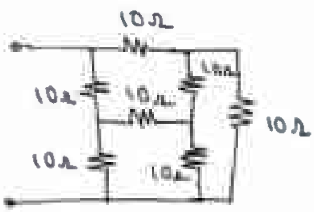

Fig.Q1(b)

(08 Marks)

c. Discuss the dependent sources.

(04 Marks)

OR

2 a. Using loop analysis, find the current through 10Ω resistor for the circuit shown in Fig.Q2(a).

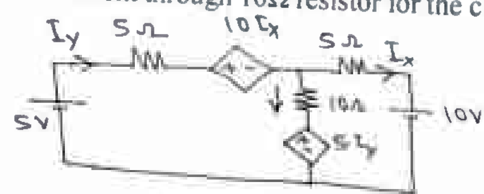

Fig.Q2(a)

(08 Marks)

b. For the network shown in Fig.Q2(b), determine node voltages V_1, V_2, V_3 and V_4 using nodal analysis.

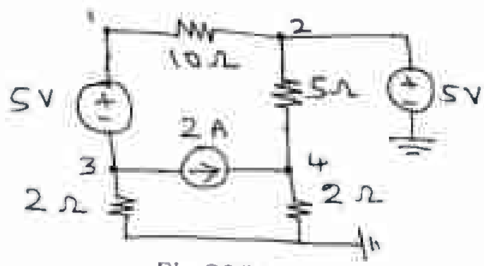

Fig.Q2(b)

(08 Marks)

c. Explain the super Mesh with example.

(04 Marks)

Module-2

3 a. Using super position theorem, find the current through 20Ω resistor shown in Fig.Q3(a).

Fig.Q3(a)

(08 Marks)

b. Using Millman's theorem, determine the current through (2 + j2)Ω impedance for the network shown in Fig.Q3(b).

Fig.Q3(b)

(08 Marks)

c. State the Norton's theorem and also write the procedure to be followed for solving the problem.

(04 Marks)

OR

4 a. What should be the value of R such that maximum power transfer can takes place from the rest of the network to R. Obtain the amount of this power for circuit shown in Fig.Q4(a).

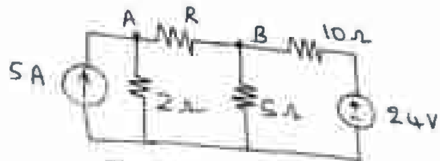

Fig.Q4(a)

(08 Marks)

b. Obtain the Thevinin's equivalent circuit cross AB for the circuit shown in Fig.Q4(b).

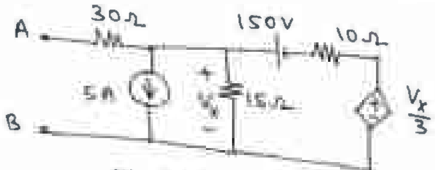

Fig.Q4(b)

(08 Marks)

c. State the maximum power transfer theorem and also write equation of P_{max} for both DC and AC circuits.

(04 Marks)

Module-3

5 a. Explain the transient behavior of the resistance, inductance and capacitor. Also write the procedure for evaluating transient behavior.

(10 Marks)

b. In the network shown in Fig.Q5(b), a steady state is reached with the swatch 'K' open. At t = 0 the switch is closed. Determine the value of $V_a(0^+)$ and $V_a(0^-)$.

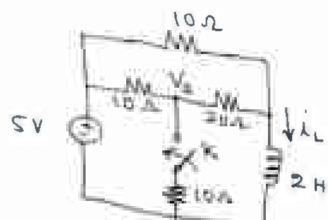

Fig.Q5(b)

(10 Marks)

OR

6 a. For the network shown in Fig.Q6(a) $V_1(t) = e^{-t}$ for $t \geq 0$ and is zero for all $t < 0$. If the capacitor is initially uncharged determine the value of $\frac{d^2v_2}{dt^2}$ and $\frac{d^3v_2}{dt^3}$ at $t = 0^+$.

Fig.Q6(a)

(10 Marks)

b. The switch 'S' is changed from position 1 to position 2 at t = 0. Steady state conditions have been reached in position 1. Find the value of i, $\frac{di}{dt}$ and $\frac{d^2i}{dt^2}$ at $t = 0^+$ for the circuit shown in Fig.Q6(b).

Fig.Q6(b)

(10 Marks)

Module-4

7 a. Find the Laplace transform of f(t) shown in Fig.Q7(a).

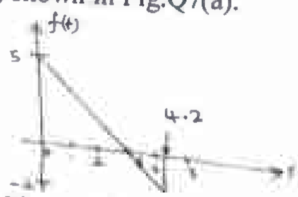

Fig.Q7(a)

(10 Marks)

b. Find the Lapalce transform of the pulse shown in Fig.Q7(b).

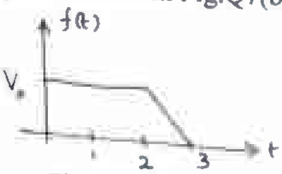

Fig.Q7(b)

(10 Marks)

OR

8 a. Find i(t) for the circuit shown in Fig.Q8(a).

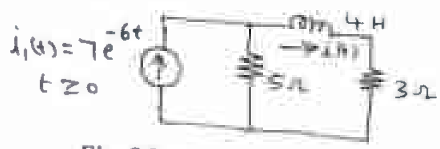

Fig.Q8(a)

(10 Marks)

b. A voltage pulse of 10V and 5μsec duration is applied to the RC network shown in Fig.Q8(b). Find the current i(t).

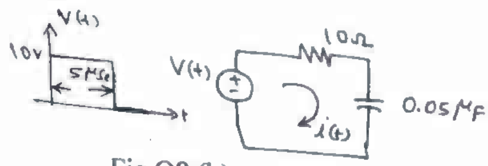

Fig.Q8 (b)

(10 Marks)

Module-5

9 a. Obtain y-parameters interms of z-parameters and h-parameters. (10 Marks)

b. For the network shown in Fig.Q9(b), find the T-parameters.

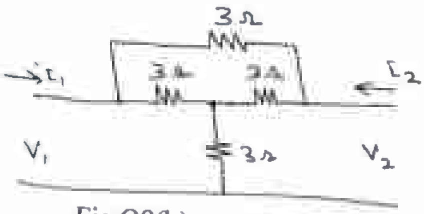

Fig.Q9(b)

(10 Marks)

OR

10 a. Derive the expression of bandwidth, half power frequencies and selectivity of a series resonance circuit. (10 Marks)

b. For the parallel resonant circuit shown in Fig.Q10(b), find I_0, I_L, I_C, f_0 and dynamic resistance.

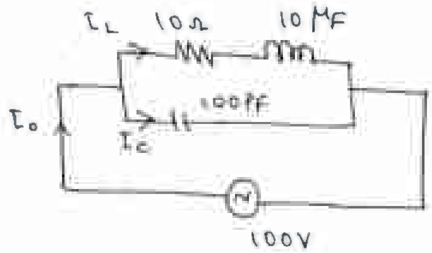

Fig.Q10(b)

(10 Marks)

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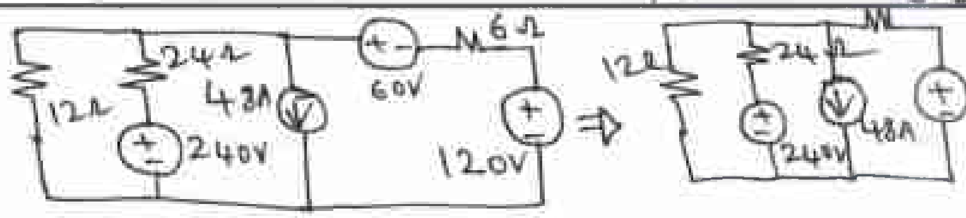
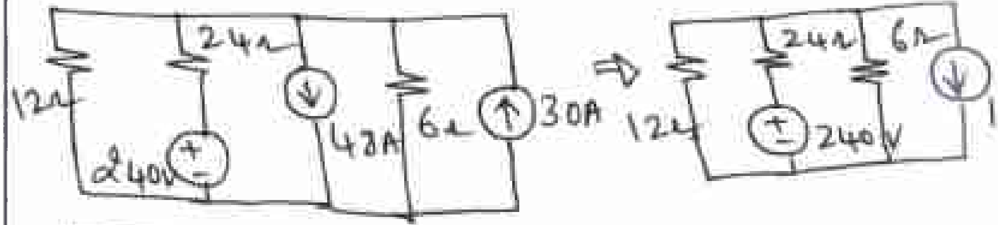
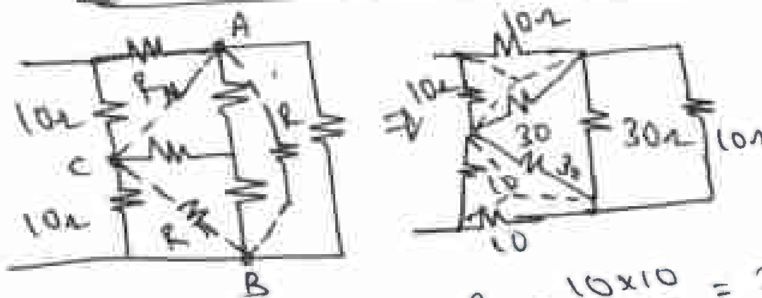
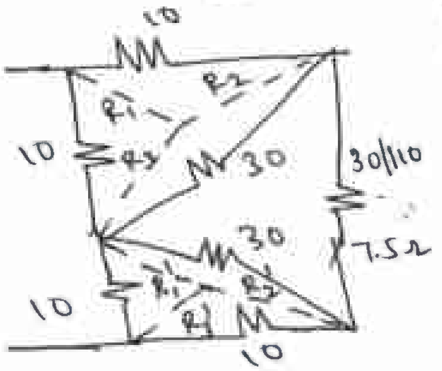
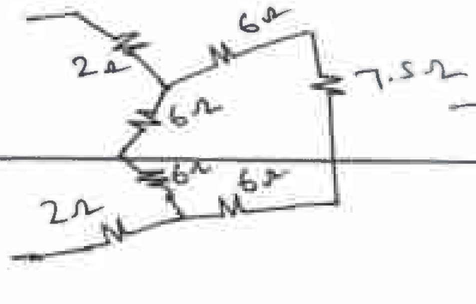
Signature of Scrutinizer

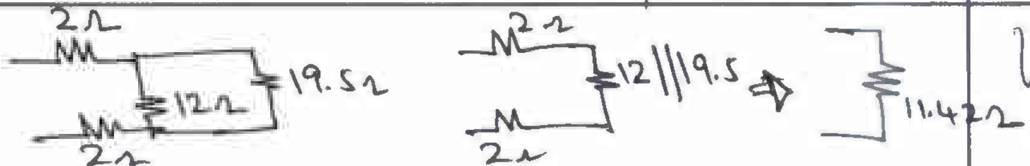
Scheme & Solutions

Subject Title : Network Theory **Subject Code :** 18EC32

Question Number	Solution P – 1/9	Marks Allocated
1 a)		2 M
		} 3M
		2 M
	$\therefore I_{12\Omega} = \frac{28 \times 4.8}{12 + 4.8} = 8\ A$	1M (8M)
b)	 $R = 10 + 10 + \frac{10 \times 10}{10} = 30\Omega$	} - 2M
	 $R_1 = \frac{10 \times 10}{50} = 2\Omega$ $R_2 = R_3 = \frac{10 \times 30}{50} = 6\Omega$ $R_1' = R_2' = \frac{10 \times 30}{50} = 6\Omega$ $R_3' = \frac{10 \times 10}{50} = 2\Omega$	} 3M
		1M

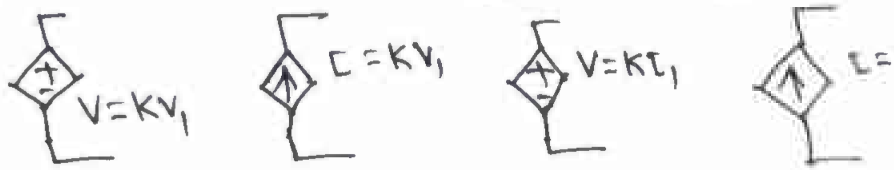
Subject Title: Network Theory   Subject Code: 18EC32

Question Number	Solution P-2/8	Marks Allocated



2M (8M)

c) (i) VCVS (ii) VCCS (iii) CCVS (iv) CCCS



4M

2 a) Loop ①

$5 - 5I_y - 10I_x - 10(I_y - I_x) - 5I_y = 0$ — 3M

$\therefore \boxed{I_y = 0.25A}$

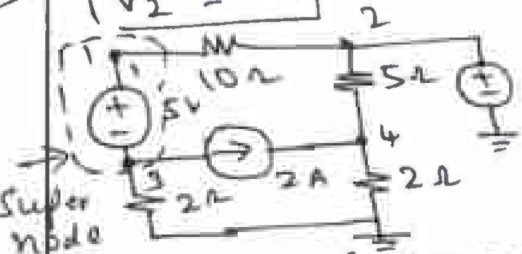
Loop ②

$-5I_x - 10 + 5I_y + (I_y - I_x)10 = 0$ — 3M

$\therefore \boxed{I_x = -0.4166\ A}$ — 2M

$\boxed{I_{10\Omega} = I_y - I_x = 0.666\ A}$ — (8M)

b) $\boxed{V_2 = 5V}$ — 1M



$V_1 - 5 - V_3 = 0$

$\boxed{V_3 = V_1 - 5}$ — 1M

KCL at super node

$\frac{V_1 - V_2}{10} + \frac{V_3}{2} + 2 = 0$

$\frac{V_1 - 5}{10} + \frac{V_1 - 5}{2} + 2 = 0$

$\therefore \boxed{V_1 = 1.66V}$ — 3M

$\therefore \boxed{V_3 = 1.66 - 5 = -3.33V}$

KCL at ④

$\frac{V_4 - V_2}{5} + \frac{V_4}{2} - 2 = 0$

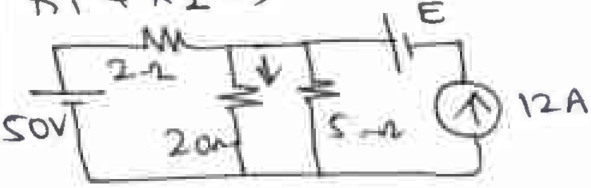
$\frac{V_4 - 5}{5} + \frac{V_4}{2} - 2 = 0$

$\boxed{V_4 = 4.28V}$ — 3M

(8M)

c) Supermesh → Definition with Example — 4M

3 a) R_1 & R_2 → redundant, hence neglected



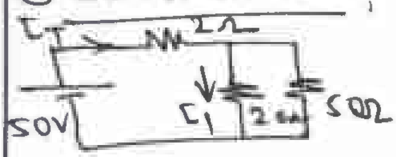
1M

R_1 & R_2 → Redundant

Subject Title : Network Theory   Subject Code : 18EC32

Question Number	Solution P-3 | 8	Marks Allocated

(i) consider 50V;



$R_T = 20 \| 5 + 2 = 6\Omega$

$I_T = \frac{V}{R_T} = \frac{50V}{6} = 8.33A$

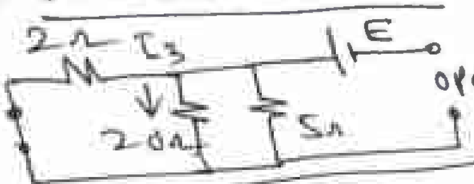
$I_1 = \frac{I_T \times 5}{20+5} = 1.66A$ — 3M

(ii) consider 12A source

$I = \frac{12 \times 5}{5 + (2 \| 20)} = 8.8A$ — 2M

$I_2 = \frac{I \times 2}{2+20} = 0.8A$

(iii) consider E source

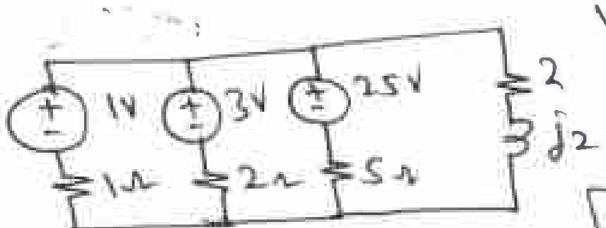


$I_3 = 0$ — 1M

$\therefore I_{20\Omega} = I_1 + I_2 + I_3 = 2.46A$ — 1M

(8M)

b)

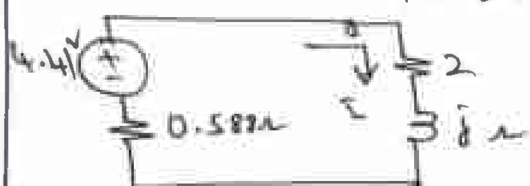


$V_0 = \frac{V_1 Y_1 + V_2 Y_2 + V_3 Y_3}{Y_1 + Y_2 + Y_3}$

$= \frac{\frac{1}{1} + \frac{3}{2} + \frac{25}{5}}{1 + \frac{1}{2} + \frac{1}{5}}$

$V_0 = 4.41V$ — 3M

$Z = \frac{1}{Y} = \frac{1}{Y_1 + Y_2 + Y_3} = 0.588\Omega$ — 2M



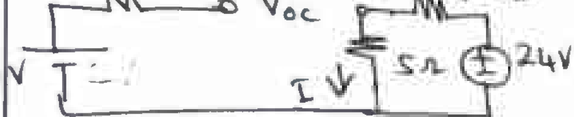
$I_{(2+j2)} = \frac{4.41}{2.588 + j2}$

$I_{(2+j2)} = 1.35 \angle -37.69° A$ — 3M

(8M)

c) Statement + procedure — 2+2 = 4M

4 a)

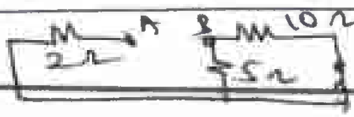


$I = \frac{V}{R} = \frac{24}{15} = 1.6A$

$V_B = I \times 5 = 8V$ — 2M

but $V_A = 10V$

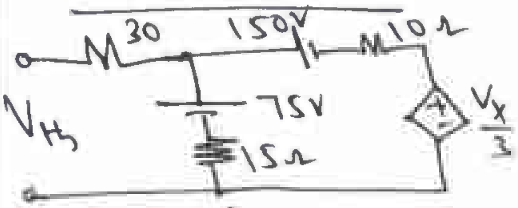
$V_{oc} = V_{AB} = V_A - V_B = 2V$ — 1M



$\Rightarrow R_{th} = 10 \| 5 + 2 = 5.33\Omega$ — 3M

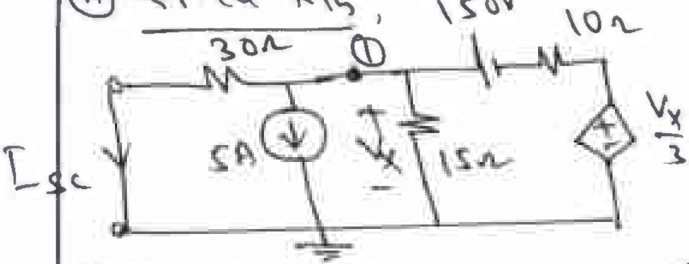
Subject Title : Network Theory　　　　Subject Code : 18EC32

Question Number	Solution　P-4/8	Marks Allocated
	$\therefore R = R_{th} = 5.33\Omega$	
	$P_{max} = \frac{V_{th}^2}{4R_L} = \frac{2^2}{4\times 5.33} = 0.1875\,W$	2M (8M)
4 b)	(i) find V_{th} or V_{oc}	



$V_{th} = 75V$ — 2M

(ii) find R_{th}:



$V_x = V_1$ — 2M

KCL at ①

$$\frac{V_1}{30} + 5 + \frac{V_1}{15} + \frac{V_1 - 150 - \frac{V_1}{3}}{10} = 0$$

$\therefore V_1 = 60V$　　$\therefore I_{sc} = \frac{V_1}{30} = 2A$ — 2M

$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{75}{2} = 37.5\Omega$ — 2M (8M)

c) Statement — 2M

$P_{max} = \frac{V_{th}^2}{4R_L}$ — DC

$P_{max} = \frac{(V_{th})^2}{8R_{th}}$ — AC　　2M (4M)

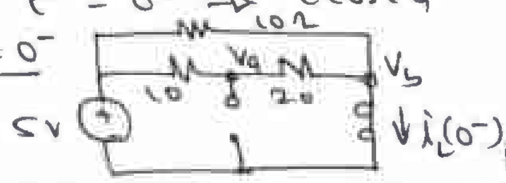
5 a) Analysis of Transient behaviour of R, L & C — 7M

Procedure — 3M (10M)

b) At $t = 0^-$ ⇒ open ⇒ steady state — 1M

$t = 0^+$ ⇒ closed

at $t = 0^-$



$i_L(0^-) = \frac{5}{30\|10} = 0.66A$

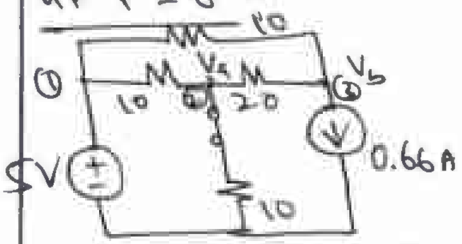
$\therefore i_L(0^-) = i_L(0^+)$

$V_a(0^-) = \frac{5\times 20}{30} = 3.33V$　　4M

Subject Title : Network Theory Subject Code : 18EC32

Question Number	Solution p-5/8	Marks Allocated

at $t = 0^+$:



KCL at ② & ③

$$\frac{V_a - 5}{10} + \frac{V_a}{10} + \frac{V_a - V_b}{20} = 0$$

$$0.25 V_a - 0.05 V_b = 0.5 \quad — ①$$

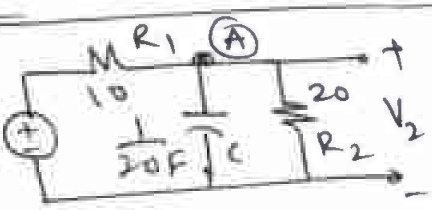
$$0.66 + \frac{V_b - 5}{10} + \frac{V_b - V_a}{20} = 0$$

$$-0.05 V_a + 0.15 V_b = -0.16 \quad ②$$ — 5M

∴ Solving ① & ②

$$\boxed{V_a(0^+) = 1.91 V \ \& \ V_b(0^+) = -0.42 V}$$

6 a)



$$\boxed{V_2(0^-) = V_2(0^+) = 0}$$ — 1M

KCL at A

$$\frac{V_2(t) - V_1(t)}{10} + \frac{1}{20}\frac{dV_2(t)}{dt} + \frac{V_2(t)}{20} = 0$$

$$\boxed{0.15 V_2(t) + 0.05 \frac{dV_2(t)}{dt} = 0.1 e^{-t}} \quad —①$$ — 3M

(i) at $t = 0^+$: $$\boxed{\frac{dV_2(0^+)}{dt} = 2 V/sec}$$ — 2M

Diffn Eqn ①, we get

$$0.15 \frac{dV_2(t)}{dt} + 0.05 \frac{d^2 V_2(t)}{dt^2} = -0.1 e^{-t} \quad ②$$

(ii) at $t = 0^+$: $$\boxed{\frac{d^2 V_2(0^+)}{dt^2} = -8 V/sec^2}$$ — 2M

Diffn Eqn ②, we get

$$0.15 \frac{d^2 V_2(t)}{dt^2} + 0.05 \frac{d^3 V_2(t)}{dt^3} = 0.1 e^{-t}$$

(iii) at $t = 0^+$

$$\boxed{\frac{d^3 V_2(t)}{dt^3} = 26 V/sec^3}$$ — 2M

(10M)

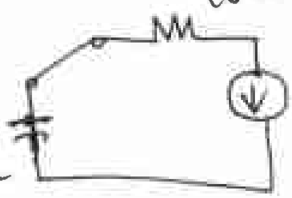
b) at $t = 0^-$ ⇒ Position 1 ⇒ Steady State

$$i(0^-) = \frac{20}{10} = 2A$$

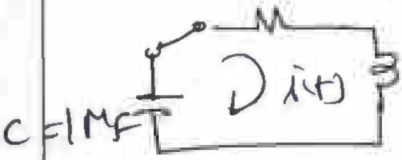
$$V_c(0^-) = V_c(0^+) = 0V$$ — 2M

Q.No. | Marks

<u>at $t = 0^+$</u>



$i(0^+) = i(0^-) = 2A$ — 1M



$R\,i(t) + L\frac{di(t)}{dt} + \frac{1}{C}\int i\,d\tau = 0$ — ① } -3M

$R\,i(t) + L\frac{di(t)}{dt} + V_c(t) = 0$

(ii) <u>at $t = 0^+$</u> : $\boxed{\frac{di(0^+)}{dt} = -20\,A/sec}$

① diffn Eqn ①

$R\frac{di(t)}{dt} + L\frac{d^2 i(t)}{dt^2} + \frac{i(t)}{C} = 0 \Rightarrow \boxed{\frac{d^2 i(0^+)}{dt^2} = -1.99\times10^6\,A/sec^2}$ — 4M (10M)

7 a) $f(t) = x(t)\,g(t)$

$= \left[-\frac{5}{3}t + 5\right]\left[u(t) - u(t-4.2)\right]$ — 2M

After simplification

$f(t) = -\frac{5}{3}t\,u(t) + \frac{5}{3}(t-4.2)\,u(t-4.2) + 2\,u(t-4.2) + 5u(t)$ — 3M

$\therefore F(s) = \mathcal{L}\{f(t)\} = \frac{-5}{3s^2} + \frac{5}{3s^2}e^{-4.2s} + \frac{2}{s}e^{-4.2s} + \frac{5}{s}$

$\therefore \boxed{F(s) = \frac{-5 + 5e^{-4.2s} + 6s\,e^{-4.2s} + 15s}{3s^2}}$ — 5M (10M)

b) $f(t) = \begin{cases} V_0, & 0 < t < 2 \\ -V_0 t + 3V_0, & 2 < t < 3 \end{cases}$ — 2M

$= V_0\left[u(t) - u(t-2)\right] + \left[-V_0 t + 3V_0\right]\left[u(t-2) - u(t-3)\right]$

$f(t) = V_0 u(t) - V_0 u(t-2) - V_0 t\,u(t-2) + V_0 t\,u(t-3) + 3V_0 u(t-2) - 3V_0 u(t-3)$ — 3M

$\boxed{f(t) = V_0 u(t) - V_0 r(t-2) + V_0 r(t-3)}$

$\therefore \boxed{F(s) = \mathcal{L}\{f(t)\} = \frac{V_0}{s} - \frac{V_0}{s^2}e^{-2s} + \frac{V_0}{s^2}e^{-3s}}$ — 5M (10M)

8 a)

KCL at (V1)

$\frac{V_1}{5} + i = 7e^{-6t}$

Also $V_1 = 3i + 4\frac{di}{dt}$

Hence $\frac{1}{5}\left[3i + 4\frac{di}{dt}\right] + i = 7e^{-6t}$

$\Rightarrow di/dt + 2i = \frac{35}{4}e^{-6t}$ — (4M)

Taking LT

$\left[s\,I(s) - i(0)\right] + 2I(s) = \frac{35}{4}\frac{1}{s+6}$

$I(s) = \frac{35}{4}\frac{1}{(s+2)(s+6)}$

using PFE

$I(s) = \frac{K_1}{s+2} + \frac{K_2}{s+6}$

$= \frac{35}{16}\left[\frac{1}{s+2}\right] - \frac{35}{16}\left[\frac{1}{s+6}\right]$

$\therefore \boxed{i(t) = \frac{35}{16}\left[e^{-2t} - e^{-6t}\right]u(t)}$ — (6M)

Subject Title : Network Theory Subject Code : 18EC32

Question Number	Solution P-7/8	Marks Allocated

8 b)

$v(t) = v_1(t) - v_2(t) = 10\,u(t) - 10\,u(t-t_0)$ — 1M

$V(s) = \mathcal{L}\{v(t)\} = \frac{10}{s}(1 - e^{-t_0 s})$ — 1M

$\therefore I(s) = \frac{V_s}{R + \frac{1}{Cs}} = \frac{10}{R}\left[\frac{1}{s+\frac{1}{RC}} - \frac{1}{s+\frac{1}{RC}} e^{-t_0 s}\right]$ — 3M

Taking ILT

$i(t) = \frac{10}{R} e^{-\frac{t}{RC}} u(t) - \frac{10}{R} e^{-\frac{t}{RC}} u(t)\Big|_{t \to t - t_0}$

$\therefore i(t) = e^{\frac{-t}{0.5\times10^{-6}}} u(t) - e^{-\frac{(t-5\times10^{-6})}{0.5\times10^{-6}}} u(t-5\times10^{-6})$ — 5M

(10M)

9 a)

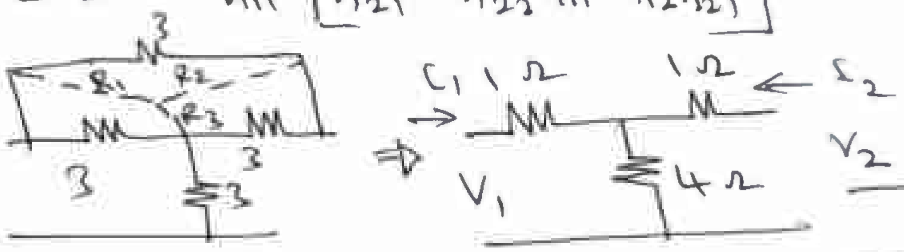
Obtaining (starting from basic equation)

$[Y] = \frac{1}{\Delta z}\begin{bmatrix} z_{22} & -z_{12} \\ -z_{21} & z_{11} \end{bmatrix}$ — 5M

&

$[Y] = \frac{1}{h_{11}}\begin{bmatrix} 1 & -h_{12} \\ h_{21} & h_{22}h_{11} - h_{12}h_{21} \end{bmatrix}$ — 5M

b)



1M

$R_1 = R_2 = R_3 = \frac{9}{9} = 1\,\Omega$ — 1M

(1) When $I_2 = 0$

$V_2 = 4 I_1$

$\frac{I_1}{V_2} = C = \frac{1}{4}$ ℧ — (2M)

$V_1 = 5 I_1$

$V_1 = 5 \cdot \frac{1}{4} V_2$

$\frac{V_1}{V_2} = A = \frac{5}{4}$ — (2M)

(2) When $V_2 = 0$

$I_2 = -\frac{I_1 \cdot 4}{5}$

$-\frac{I_1}{I_2} = D = \frac{5}{4}$ — (2M)

$V_1 = 5 I_1 + 4 I_2$

$= 5\left(-\frac{5}{4}\right) I_2 + 4 I_2$

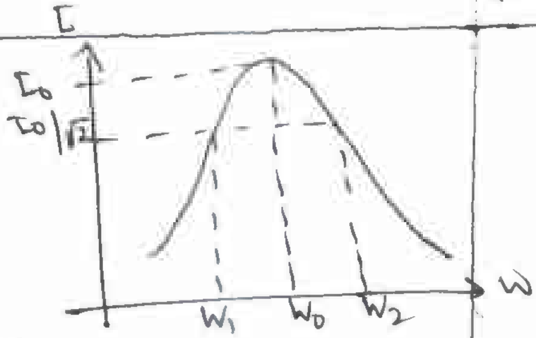
$-\frac{V_1}{I_2} = B = \frac{9}{4}\,\Omega$ — (2M)

$[T] = \begin{bmatrix} 5/4 & 9/4 \\ 1/4 & 5/4 \end{bmatrix}$

(10M)

Sub: Network Theory — Sub: Code : 18EC32

Q. No	Solution P-8/8	Marks allocated
10 a)	Starting from basic equation to get	



$$\left(WL - \frac{1}{WC}\right) = \pm R \quad \text{—(1)}$$

$$W_1 L - \frac{1}{W_1 C} = -R$$

$$W_1 = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}} \quad \text{—(2)}$$

$$\text{III}^{ly}\left(W_2 L - \frac{1}{W_2 C}\right) = R$$

⇒ Half power frequencies — 5M

$$W_2 = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}} \quad \text{—(3)}$$

— 3M

$$W_2 - W_1 = \frac{R}{L} \Rightarrow \boxed{f_2 - f_1 = \frac{R}{2\pi L}} \Rightarrow BW$$

— 2M

$$Q = \frac{W_0}{W_2 - W_0} = \frac{2\pi f_0}{R/L} = \frac{2\pi f_0 L}{R} = \boxed{\frac{W_0 L}{R}} \Rightarrow \text{Selectivity}$$

(10M)

b)

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R_L^2}{L^2}} = 5.03\ MHz$$ — 2M

$$Z_0 = \frac{L}{CR_L} = 10K\Omega$$ — 2M

$$I_0 = \frac{V}{Z_0} = \frac{100}{10K} = 0.01A$$ — 2M

$$I_L = \frac{V}{R_L + jX_L} = \frac{100}{10 + j2\pi f_0 L} = \frac{100}{10 + j316.04} = 0.316\angle -88.18^\circ\ A$$ — 2M

$$I_C = \frac{V}{-jX_C} = 100jWC = 100(j2\pi f_0 C)$$

— 2M

$$\boxed{I_C = 0.316\angle 90^\circ\ A}$$

(10M)