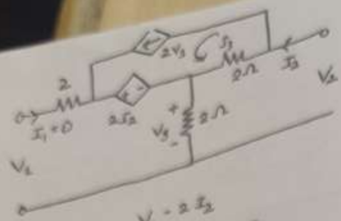
$h_{12} = \frac{V_1}{V_2}\Big|_{I_1=0}$ $\quad h_{22} = \frac{I_2}{V_2}$



$2I_3 = V_1 - 2I_2$

$4I_2 = V_1$ —— ①

$4I_2 - 2I_3 = V_2$ —— ②

$4I_2 - 2(4I_2) = V_2$

$4I_2 - 8I_2 = V_2$

$-4I_2 = V_2$

$\Rightarrow \boxed{\frac{I_2}{V_2} = -\frac{1}{4}\,\mho = h_{22}}$ —— (1M)

$I_3 = 2V_3 = 2(2I_2) = 4I_2$

$\therefore I_3 = 4I_2$ —— ③

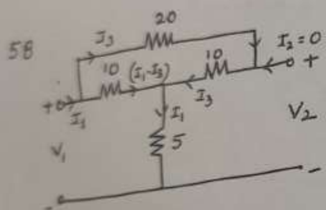
$V_1 = 4I_2 \Rightarrow V_1 = -V_2$

$V_2 = -4I_2$

$\therefore \boxed{\frac{V_1}{V_2}\Big|_{I_1=0} = -1 = h_{12}}$

$\begin{bmatrix} -2 & -1 \\ -1.5 & -1/4 \end{bmatrix}$ —— (1M)

58



$V_1 = 10(I_1 - I_3) + 5I_1$

$V_1 = 15I_1 - 10I_3$ —— ①

$V_2 = 5I_1 + 10I_3$ —— ②

$I_3 = I_1 \cdot \frac{10}{(10+20+10)} = I_1/4$

Substg ③ in ① and ②

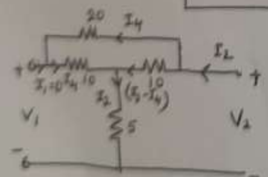
$V_1 = 15I_1 - 10\left(\frac{I_1}{4}\right) = 12.5I_1$

$\therefore \boxed{Z_{11} = V_1/I_1\Big|_{I_2=0} = 12.5\Omega}$

$V_2 = 5I_1 + 10\left(\frac{I_1}{4}\right)$

$V_2 = 7.5I_1$

$\boxed{Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} = 7.5}$



$V_1 = 10I_4 + 5I_2$ —— ①

$V_2 = 10(I_2 - I_4) + 5I_2$

$V_2 = 15I_2 - 10I_4$ —— ②

$I_4 = I_2 \cdot \frac{10}{40} = (I_2/4)$ —— ③

$V_1 = 10\left(\frac{I_2}{4}\right) + 5I_2$

$V_1 = 7.5I_2$

$\boxed{\frac{V_1}{I_2} = Z_{12} = 7.5\Omega}$

$V_2 = 15I_2 - 10\left(\frac{I_2}{4}\right)$

$V_2 = 12.5I_2$

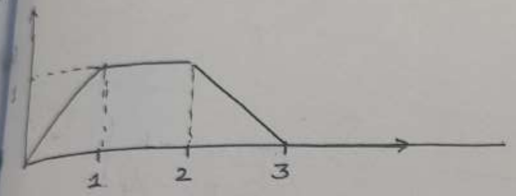
$\boxed{\frac{V_2}{I_2} = Z_{22} = 12.5\Omega}$

$$Z = \begin{bmatrix} 12.5 & 7.5 \\ 7.5 & 12.5 \end{bmatrix} \qquad \Delta Z = 100 \qquad Y = [Z]^{-1}$$

$Y_{11} = 0.0125\ \mho$	$Y_{22} = 0.0125\ \mho$
$Y_{12} = -0.075\ \mho$	$Y_{21} = -0.075\ \mho$

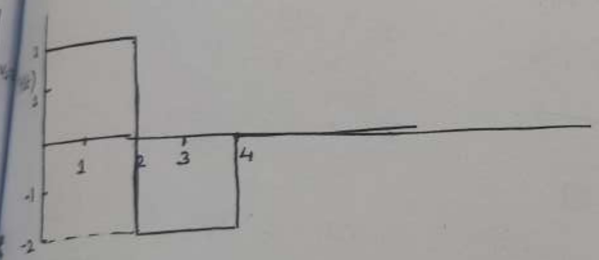
$\boxed{1 \times 4 = 4M}$

$$x(t) = r(t) - r(t-1) - r(t-2) + r(t-3)$$



— (1M)

$$Y(t) = 2u(t) - 4u(t-2) + 2u(t-4)$$



(1M)

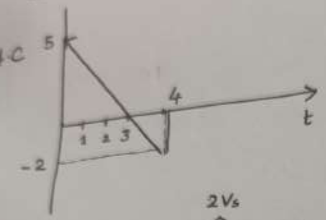
$$= \frac{1.5}{s+1} - \frac{2.5}{s+1}\left[(s+1)-1\right] \cdot \frac{e^{-2s}}{s}$$

$$= \frac{1.5}{s+1} - 2.5\left[1 - \frac{1}{s+1}\right] \cdot \left(\frac{e^{-2s}}{s}\right)$$

$$\therefore\ i(s) = \frac{1.5}{s+1} - 2.5\,\frac{e^{-2s}}{s} - \frac{2.5}{s+1}\cdot\frac{e^{-2s}}{s}$$

$$\boxed{i(t) = 1.5e^{-t} - 2.5\,U(t-2) - 2.5e^{-t}\cdot U(t-2)}$$ — (2M)

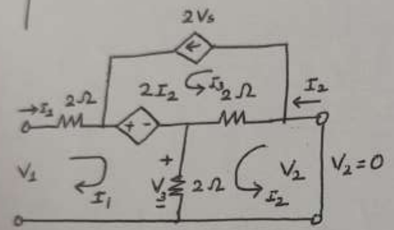
4.C



$$V(t) = 5\,U(t) - \frac{5}{3}r(t) + \frac{5}{3}r(t \ldots)$$
$$- 2\,r(t-3) + 2\,r(t \ldots)$$
$$+ 2\,U(t-4)$$

——— (2M)

5.A



$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$
$$h_{11} = \frac{V_1}{I_1}\Big|_{V_2=0}$$

$$I_3 = 2V_3$$
$$= 2\left[2(I_1+I_2)\right]$$
$$I_3 = 4I_1 + 4I_2$$ — (2)

$$4I_1 + 2I_2 = V_1 - 2I_2$$
$$4I_1 + 4I_2 = V_1$$ — (1)

$$4I_2 + 2I_1 - 2I_3 = 0$$
$$4I_2 + 2I_1 - 2\left[4I_1 + 4I_2\right] = 0$$
$$4I_2 - 8I_2 + 2I_1 - 8I_1 = 0$$
$$-4I_2 - 6I_1 = 0 \Rightarrow \frac{I_2}{I_1} = \frac{6}{-4} = \boxed{-1.5 = h_{21}}$$

Subst. in eqn (1)

$$4I_1 + 4(-1.5I_1) = V_1$$
$$4I_1 - 6I_1 = V_1$$
$$-2I_1 = V_1 \Rightarrow \boxed{\frac{V_1}{I_1} = -2\Omega = h_{11}}$$

3B

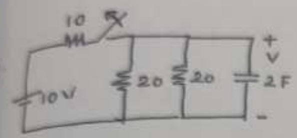
$$Y_1 = \left(\frac{1}{10-j5}\right) \times \frac{10+j5}{10+j5} = \frac{10+j5}{125} = \frac{10}{125} + j\left(\frac{5}{125}\right)$$

$$Y_2 = \frac{1}{R_L+j10} \cdot \frac{R_L - j10}{(R_L - j10)} = \frac{R_L - j10}{R_L^2+100} = \left(\frac{R_L}{R_L^2+100}\right) - j\left(\frac{10}{R_L^2+100}\right)$$

$$Y = Y_1 + Y_2 = \frac{10}{125} + \frac{R_L}{R_L^2+100} + j\left[\frac{5}{125} - \frac{10}{R_L^2+100}\right] \text{------ (02M)}$$

For Resonance susceptance = 0

$$\frac{5}{125} = \frac{10}{R_L^2+100} \Rightarrow \boxed{R_L = 12.247\ \Omega} \text{--- (1M)}$$



At $t=(0^-)$

$$V_c(0^-) = \frac{10}{(10+10)} \times 10 = 5V$$

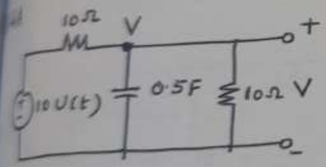
$$= V_c(0^+) = V = 5V \text{ ——— (1M)}$$

At $t=\infty$ (when switch opend) $V_{c\infty} = 0$

$$\therefore V(t) = V_\infty - [V_\infty - V_0]\, e^{-t/RC}$$

$$= 0 - [0-5]\, e^{-t/10\times 2}$$

$$\boxed{V(t) = 5e^{-0.05t}} \text{ ---- ——— (1M)}$$



At $t=(0^-)$ $V_c(0^-) = 0 = V_c(0^+) = V(0^+)$

$$\therefore V(0^+) = 0 \text{ ——— (1M)}$$

At $t=0^+$

$$1 = C\frac{dV}{dt} + \frac{2V}{10} \text{ — (A)}$$

$$1 = 0.5\frac{dV(0^+)}{dt} + \frac{V(0^+)}{10}$$

$$\Rightarrow \boxed{\frac{dV(0^+)}{dt} = 2V/\text{sec}} \text{ — (2M)}$$

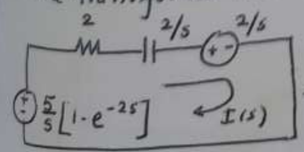
Diffy equation (A)

$$0 = C \cdot \frac{d^2V}{dt^2} + \frac{2}{10}\frac{dV}{dt}$$

$$= 0.5 \cdot \frac{d^2V(0^+)}{dt^2} = -\frac{2}{10} \cdot \frac{dV}{dt}(0^+) \Rightarrow \frac{d^2V(0^+)}{dt^2} = \boxed{-0.8V/\text{sec}^2} \text{ — (2M)}$$

4B

The transformed network



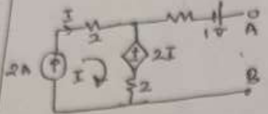
— (1M)

$$I(s) = \frac{\frac{5}{s}\left[1-e^{-2s}\right] - \frac{2}{s}}{\left(2+\frac{2}{s}\right)} = \frac{\frac{3}{s} - \frac{5}{s}e^{-2s}}{\frac{2s+2}{s}} \text{ — (1M)}$$

$$= \frac{3-5e^{-2s}}{2(s+1)} = \left(\frac{1.5}{s+1}\right) - \frac{(2.5)\,e^{-2s}}{(s+1)}$$

$$: \frac{1.5}{(s+1)} - \frac{2.5}{(s+1)} \cdot s \cdot \left(\frac{e^{-2s}}{s}\right)$$

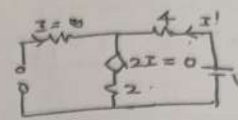
2B.



Ckt $\Rightarrow$ $\boxed{I = 2A}$

$\therefore V_{oc} = V_{AB} = 2I + 2I + 1 = \underline{9V}$

Rth:

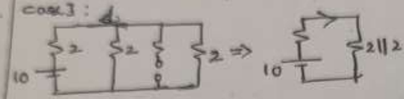


$I' = \frac{V'}{6}$

$\boxed{\frac{V'}{I'} = R_{th}}$

$\boxed{V_{oc} = 9V, \quad R_{th} = 6\,\Omega}$

2C. case I:

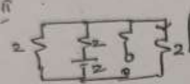


$2 \| 2 = 1\Omega$

$I = \frac{10}{3}$

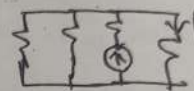
$\therefore I_{10V} = \frac{10/3 \times 2}{2+2} = \frac{5}{3}$

case II



$\boxed{I_{2V} = \frac{1}{3} A}$

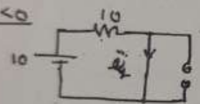
case III



$\boxed{I_{1A} = \frac{1}{3} A}$

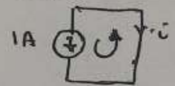
$\therefore \boxed{I_{Total} = \frac{5}{3} + \frac{1}{3} + \frac{1}{3} = 2.32A}$

3A $\underline{t<0}$



$i_L = \frac{10}{10} = 1A$

$t = 0^+$

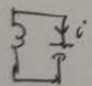


$i_L(0^-) = i_L(0^+) = 1A$

$v_C(0^-) = v_C(0^+) = 0V$

$\underline{\underline{i(t)|_{0^+} = -1A}}$

$t>0$



$L\frac{di}{dt} + \frac{1}{C}\int i\,dt = 0$

$= \frac{d^2 i}{dt^2} + 2i = 0$

$s^2 + 2 = 0$

$s = \pm j2$

$i(t) = A\cos 2t + B\sin 2t$

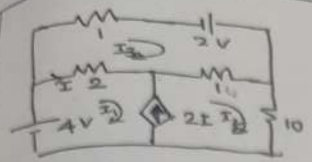
$i(0) = -1, \quad \therefore A = -1$

$\frac{di}{dt} = 0; \quad 0 = -2A\sin 2t + 2B\cos 2t$

$\Rightarrow B = 0$

$\therefore \boxed{i(t) = -\cos 2t} \quad t \geq 0$

ECE 2101 - Electrical Circuit Analysis



$2I = I_1 - I_3$, $I = I_1 - I_3$

$\Rightarrow -3I_1 + I_2 + 2I_3 = 0 \rightarrow$ 1M

Loop 3:

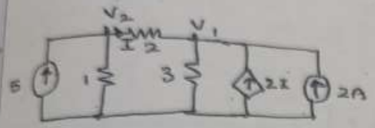
$-2I_1 - I_2 + 4I_3 = 2 \rightarrow$ 1M

Super mesh:

$2I_1 + 11 I_2 - 3I_3 = 4 \rightarrow$ 1M

Solve: $I_1 = 0.87A$, $I_2 = 0.494A$, $I_3 = 1.058A$ — 2M

5M



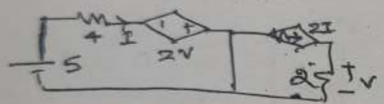
$I = \frac{V_2 - V_1}{2}$ $\therefore 2I = V_2 - V_1$

KCL at $V_2 \Rightarrow \frac{V_2}{1} + \frac{V_2 - V_1}{2} = 5 \Rightarrow \boxed{3V_2 - V_1 = 10}$ — 1M

KCL at $V_1 \Rightarrow \frac{V_1}{3} + \frac{V_1 - V_2}{2} = 2I + 2 \Rightarrow \boxed{\frac{11}{6}V_1 - \frac{3}{2}V_2 = 2}$ — 1M.

Solve $\Rightarrow$ $V_1 = 5.25V$ & $V_2 = 5.08V$ — 1M

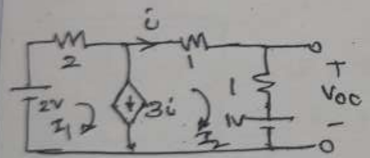
3M



$\frac{5+2V}{4} = I$

$V = 2I \times 2 = 4I$

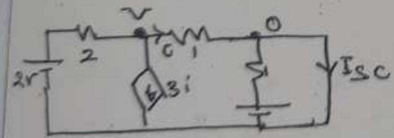
$\Rightarrow \boxed{V = -5V}$ — 2M



$\left.\begin{array}{l} 2I_1 + I_2 + I_2 + 1 = 2; \ i = I_2 \\ 3i = I_1 - I_2 \end{array}\right\}$

$\Rightarrow I_2 = 0.1A$

$\therefore \boxed{V_{oc} = 1 + 1 \times 0.1 = 1.1V}$



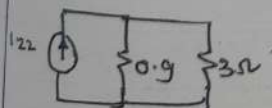
KCL $\Rightarrow \frac{2-V}{2} = 3i + \frac{V-0}{1}$ & $i = \frac{V-0}{1}$

$\Rightarrow \boxed{V = \frac{1}{4}V}$

$\because$ KCL $\Rightarrow \frac{V-0}{1} + \frac{V-0}{1} = I_{sc}$

$\therefore \boxed{I_{sc} = 1.22A}$ — 2.0M

any other method, or $\therefore \boxed{R_{Th} = \frac{V_{oc}}{I_{sc}} = 0.9\Omega}$ — 2.0M



$\therefore I_{3\Omega} = \frac{1.22 \times 0.9}{0.9 + 3} = 0.28A$ — 1M

5M

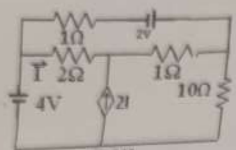


Fig.Q1A

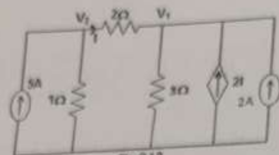


Fig.Q1B

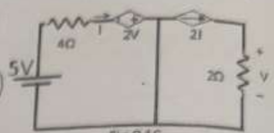


Fig.Q1C

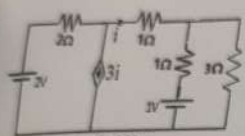


Fig.Q2A

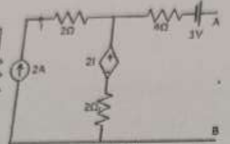


Fig.Q2B

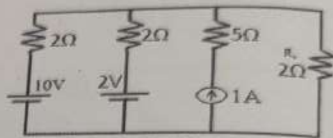


Fig. Q2C

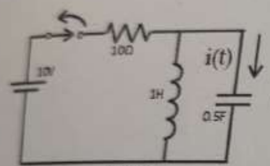


Fig. Q3A

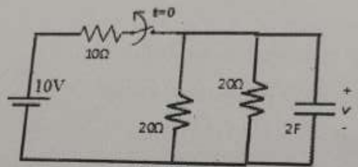


Fig. Q3C

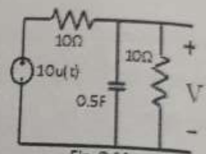


Fig. Q4A

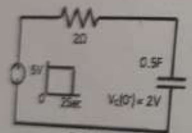


Fig. Q4B

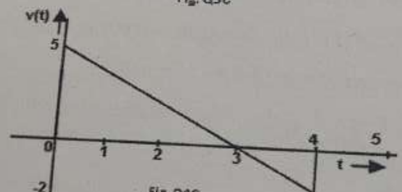


Fig. Q4C

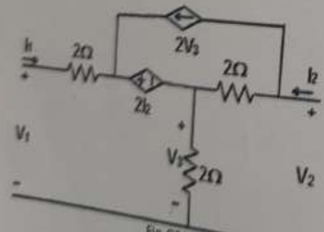


Fig. Q5A

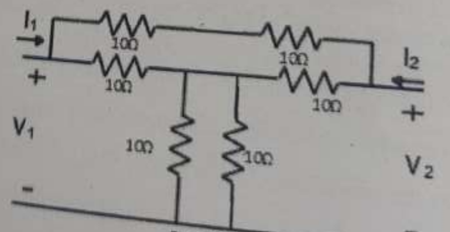


Fig. Q5B

Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

THIRD SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER EXAMINATIONS, NOV- 2017 – Regular

SUBJECT: ELECTRICAL CIRCUIT ANALYSIS [ICE 2101]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A.	Find the mesh currents in the circuit shown in Fig.Q1A.	5
1B.	Obtain node voltages V_1 and V_2 for the circuit shown in Fig.Q1B	3
1C.	Determine V in the circuit shown in Fig.Q1C.	2
2A.	Using Nortons's theorem determine current in 3Ω resistor of Fig.Q2A.	5
2B.	Obtain Thevinin's equivalent for the circuit shown in Fig.Q2B with respect to AB.	3
2C.	Using superposition theorem determine the current in R_L.	2
3A.	In the network shown Fig. Q3A, the switch is opened at t=0, a steady state having previously been attained. Obtain expression for current in complementary and particular solution form.	5
3B.	An impedance of (10-j5) Ω is connected in parallel with a coil with inductive reactance j10Ω and variable coil resistance of R_L. Find the value of R_L for which the circuit is in resonant.	3
3C.	For the circuit shown in Fig.Q3C find V, if switch is opened at t = 0 assuming that a steady state having previously been attained.	2
4A.	For the network shown in Fig. Q4A, find V, dV/dt & d^2V/dt^2 at t=0+.	5
4B.	Obtain expression for current in the circuit shown in Fig.Q4B.	3
4C.	Express the waveform shown in Fig. Q4C using basic signals.	2
5A.	For the circuit shown in Fig.Q5A, find h parameters	4
5B.	For the network shown in Fig.Q5B find Y parameters.	4
5C.	Sketch the signals (i) $x(t) = r(t) - r(t-1) - r(t-2) + r(t-3)$ (ii) $y((t) = 2u(t) - 4u(t-2) + 2u(t-4)$	2