SOLUTION

The LNM Institute of Information Technology, Jaipur

Department of Electronics and Communication Engineering

ECE103: Basic Electronics

Mid Term

2017-18 Odd Sem

Degree: B.Tech **Programme:** ECE/CCE/CSE/ME

Time: 90 Minutes **Date:** 21/09/2017 **Maximum Marks:** 30

Name: **Section:** **Roll No.**

Question No.	1	2	3	4	Total
Marks					

Q.1: For the circuit given in figure 1, if, $Z_L = 2 - j4\ \Omega$, then calculate the average power (P) consumed by each element in the circuit. Also verify the law of power conservation is followed by this circuit. [7]

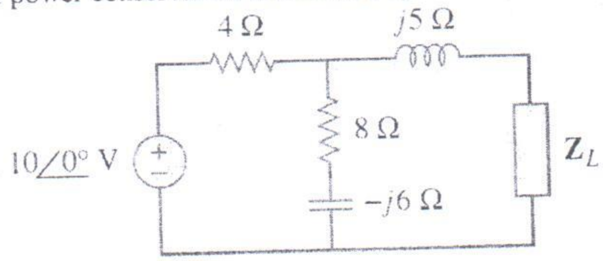
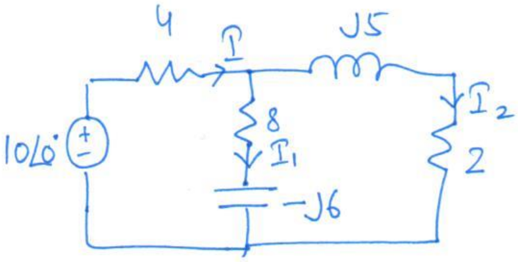


Figure 1.



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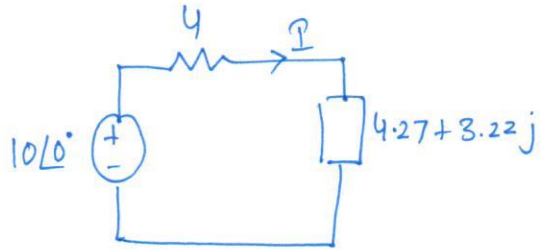


$I = \dfrac{10\angle 0^\circ}{8.27 + j3.22} = 1.05 - 0.4j$ A

$= 1.12\angle -20^\circ$ A

$I_1 = \dfrac{5.38\angle 68.19}{10.04\angle -5.7} \times 1.12\angle -20^\circ$

$= 0.60\angle 53.7^\circ$ A

$= 0.36 + j0.48$ A

$I_2 = \dfrac{10\angle -36^\circ \times 1.12\angle -20^\circ}{10.04\angle -5.7^\circ}$ [3]

$= 1.115\angle -50.3 = 0.71 + j0.86$ A

$P_{10V} = -V_\epsilon I_\epsilon \cos\theta$

$= -10 \times 1.12 \cos(20^\circ)$

$= -10.52$ W [1]

$P_{4\Omega} = V I \cos\theta$

$= I^2 R \cos(0^\circ)$

$= (1.12)^2 \times 4 = 5.02$ W

$P_{8\Omega} = |I_1|^2 R = |0.6|^2 \times 8 = 2.88$ [1]

$P_{2\Omega} = |I_2|^2 R = (1.11)^2 \times 2 = 2.64$

$P_{J5} = V_\epsilon I_\epsilon \cos\theta$ [1]

$= (J5)(I_2)(I_2)\cos 90^\circ = 0$

$P_{-J6} = 0$W.

Total Power $-10.52 + 5.02 + \cancel{2}.88 + 2.64 = 0$

[1]

→ If you assume V_s not to be V_e, then

$$P = \frac{1}{2} V I \cos\theta$$

and all the power values will be half of the calculated values.

Name: **Section:** **Roll No.**

Q2: Find the Thevenin equivalent of the circuit given below as seen from [4+4]

(a) Terminals a-b (b) terminals c-d

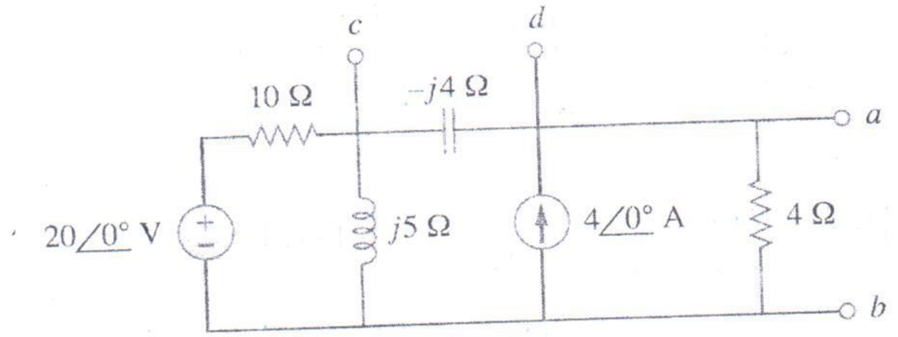
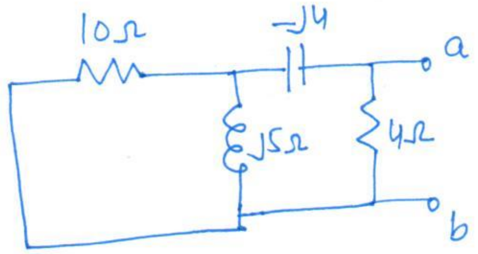


Figure 2

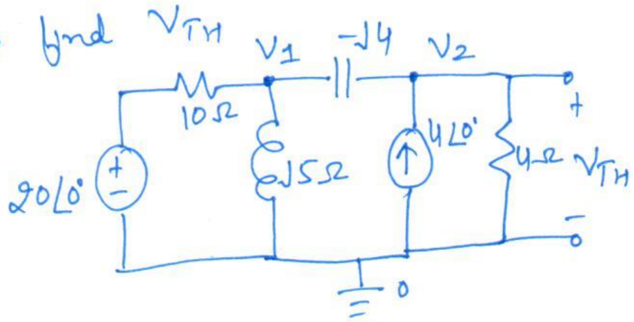
a



$R_{TH} = 4 \,||\, (-J4 + (10 \,||\, J5))$

$= 1.33\Omega$. [2]

To find V_{TH}



at node V_1

$$\frac{V_1 - 20}{10} - \frac{V_1}{J5} + \frac{V_1 - V_2}{-J4} = 0$$

$$\Rightarrow [1 + J(0.5)]V_1 - J2.5V_2 = 20 \quad (1)$$

at V_2

$$4 + \frac{V_1 - V_2}{-J4} = \frac{V_2}{4}$$

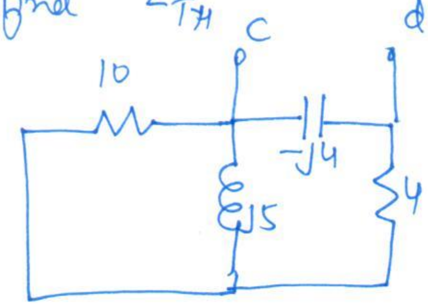
$$V_1 - (1-J)V_2 = J16 \quad (11)$$

[2]

$\therefore V_2 = 8 + J5.33.$

$V_{TH} = V_2 = 8 + J5.33 = 9.615 \angle 33.69°$

b) To find Z_{TH}



$Z_{TH} = [(10 \parallel j5) + 4] \parallel (-j4)$

$= 2.667 - j4 \ \Omega.$

[2]

To find V_{TH}.

from part a, we found $V_2 = 8 + j5.33.$

$V_1 = (1-j)V_2 + j16 = 13.33 + 13.33j$

$V_{TH} = V_1 - V_2 = 5.33 + j8$

$= 9.614 \angle 56.31.$ [2]

Name: **Section:** **Roll No.**

Q3: Determine $i(t)$ and $v(t)$ for $t > 0$ in the circuit given below (figure 3) , where $v(t)$ is the voltage across capacitor. [7]

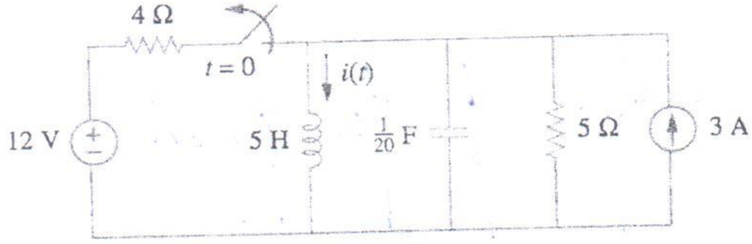
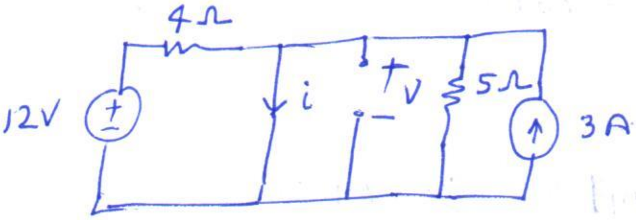
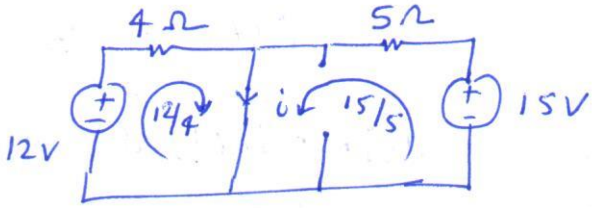


Figure 3

Sol. For $t<0$ the switch is closed and the ckt becomes



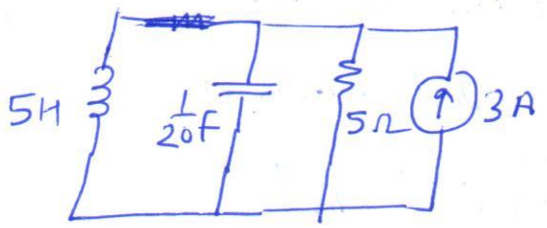
or



Then $i(0) = \frac{12}{4} + \frac{15}{5} = 3+3 = 6\,A$

and $v(0) = L\frac{di(0)}{dt} = 0$ (Short ckted)) ← 1

For $t>0$ the switch is open and ckt beomes (befor stea state)



Since this is a parallel RLC ckt.

$\alpha = \frac{1}{2RC} = \frac{1}{2\times5\times\frac{1}{20}} = 2$

and $w_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{5\times\frac{1}{20}}} = 2$ ← 1

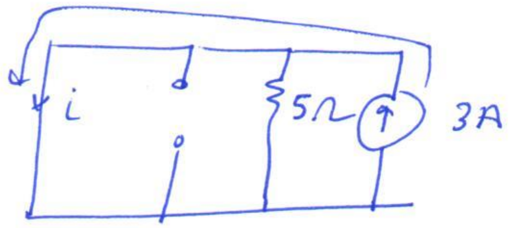
∴ $\alpha = w_0$ meanee Critically damped case of the solution.

which is in this case of RLC ckt with source

$i(t) = I_s + (A_1 + A_2 t)e^{-\alpha t}$ ← 1

Now to calculate I_s (Steady state current)

ckt becomes.



$$i(\infty) = I_s = 3A$$

then sol^n becomes.

$$i(t) = 3 + (A_1 + A_2 t) e^{-2t} \quad — (2)$$

using initial condition.

$$i(0) = 6 = 3 + (A_1 + 0) \Rightarrow \boxed{A_1 = 3} \leftarrow (1)$$

and $L \frac{d i(0)}{dt} = v(0) = 0 \Rightarrow \frac{di(0)}{dt} = 0$, then from (2)

$$\frac{di(t)}{dt} = 0 - 2(A_1 + A_2 t) e^{-2t} + A_2 e^{-2t} \quad (1)$$

at $t = 0$

$$0 = -2(3) + A_2 \Rightarrow A_2 = 6 \quad (1)$$

using $A_1 = 3,\ A_2 = 6$ (2) becomes

$$\boxed{i(t) = 3 + (3 + 6t) e^{-2t} \ A}$$

Voltage across capacitor is same as $V_L = L \frac{di(t)}{dt}$

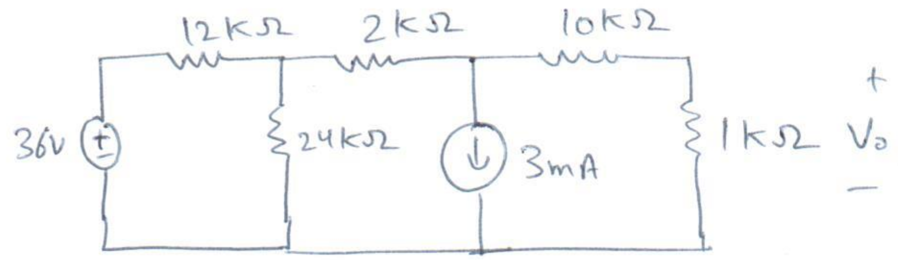
then $v(t) = 5\left[-2(3+6t) e^{-2t} + 6 e^{-2t}\right]$

$$= \cancel{5[6(1-2t)e^{-2t}}$$

$$= 5\left[\cancel{-6e^{-2t}} - 12t e^{-2t} + \cancel{6e^{-2t}}\right]$$

$$\boxed{v(t) = -60te^{-2t} \ V} \leftarrow (2)$$

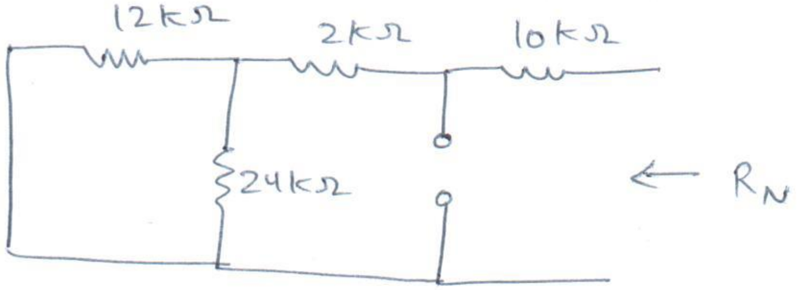
Q4 (a)



Use Norton's Theorem to find V_o ?

Soln

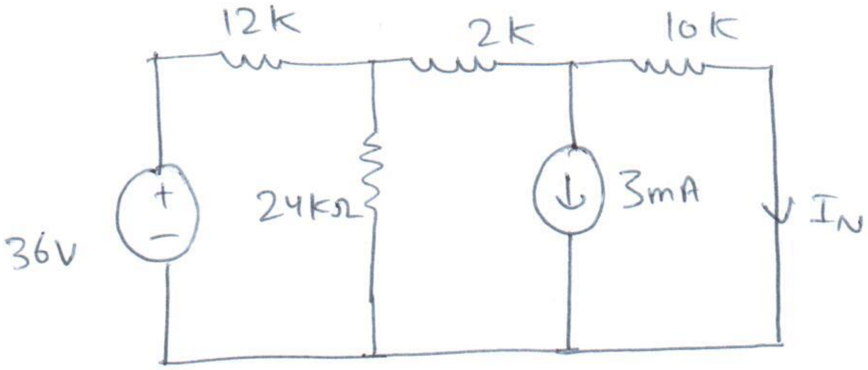
R_N



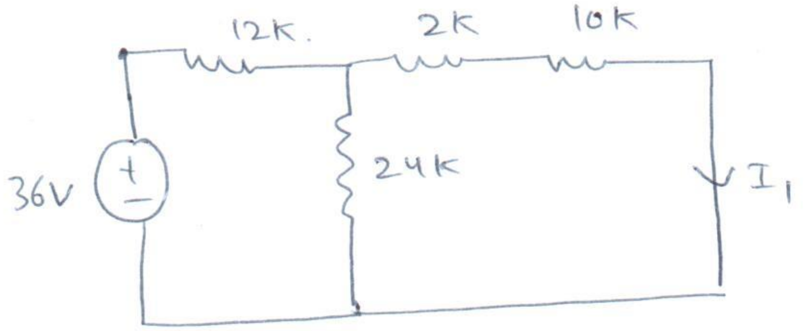
$$R_N = 10 + 2 + (12 \| 24) = 12 + 8 = 20\,k\Omega$$

1 mark

I_N

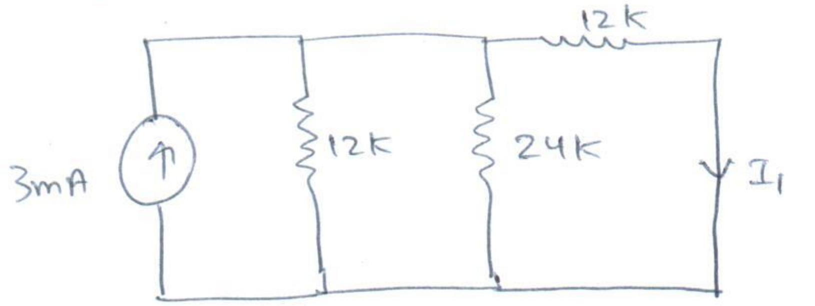


- We can use Superposition theorem to find I_N.

⇒ 

→ Fig. 1

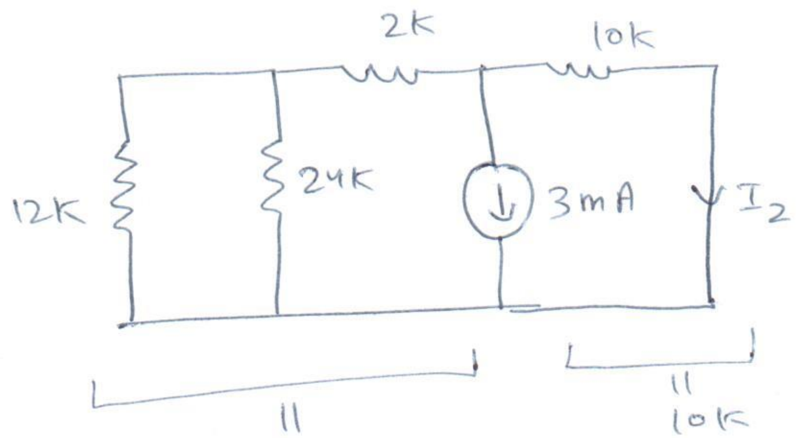
• Using Source transformation in Fig. 1, we get



• Using the Current division rule

$$I_1 = \frac{8}{8+12} \times (3\,mA) = 1.2\,mA \quad \text{—(1)}$$

⇒



$2k + (12k \| 24k) = 10k$

• Again applying Current division

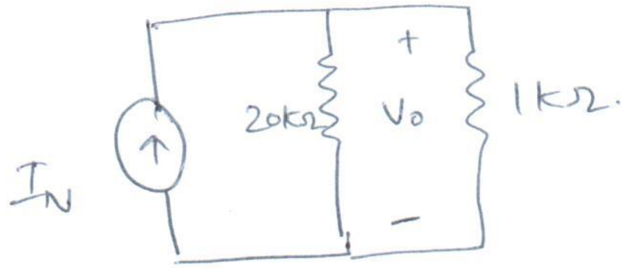
$$I_2 = -1.5\,mA$$

$$\therefore \; I_N = I_1 + I_2 = 1.2 - 1.5$$

$$\boxed{I_N = -0.3\,mA}$$

2 marks.

- The Norton Equivalent Circuit will be

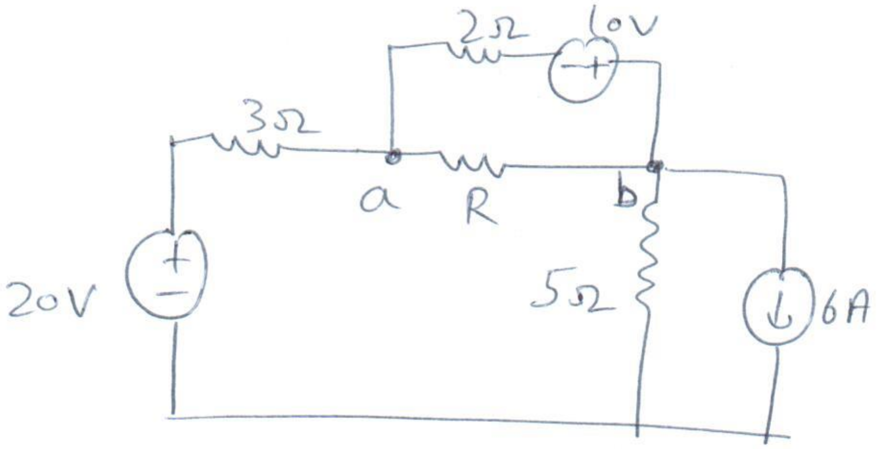


$$V_o = 1K \cdot \left[\frac{20}{20+1}\right](-0.3\,mA)$$

$$\boxed{V_o = -285.7\ mV}$$ Ans.

1 mark

Q4 (b)

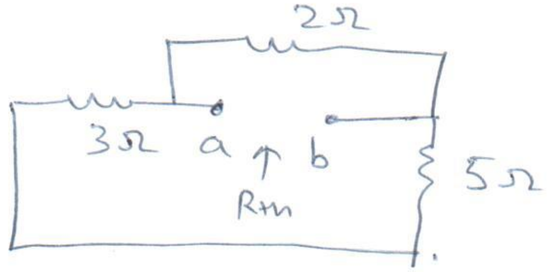


Find max. power that can be delivered to 'R'.

Soln

- We first find the Thevenin Equivalent at 'a' and 'b'

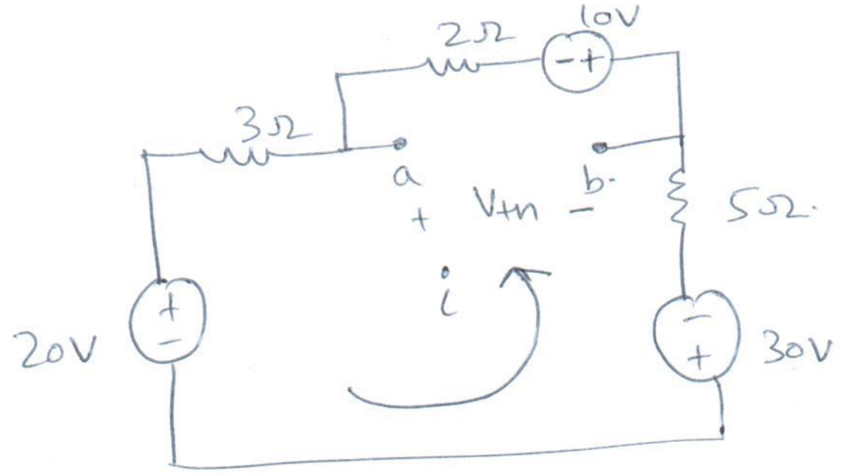
R_{th}



$R_{th} = 2 \| (3+5) = 1.6$

'1 mark'

V_{th}



Obtained b[y] doing sou[rce] transforma[tion]

- $10i + 30 + 10 + 20 = 0$

$$i = -6$$

- $V_{th} + 10 + 2i = 0$

$$V_{th} = 2V$$

" 1 mark "

- For maximum power transfer $R = R_{th}$

$$\text{Max. power} = \frac{V_{th}^2}{(4R_{th})}$$

$$= \frac{(2)^2}{4(1.6)} = 625\,\text{mW} \quad \underline{\text{Ans}}$$

" 2 marks "