KLS Vishwanathrao Deshpande Institute of Technology

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

University / Model Question Paper

Scheme & Solution

Faculty Name	:	Prof. Pooja . C. Shindhe
Course Name	:	Network Analysis
Course Code	:	BEC304
Year of Question Paper	:	Dec.2023/Jan.2024
Date of Submission	:	10-12-2024

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/1/25

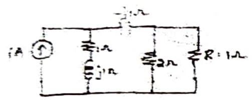
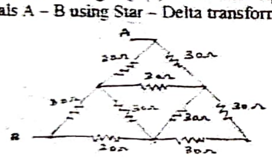
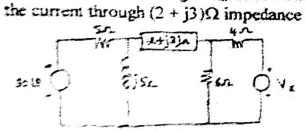
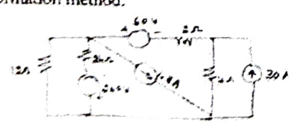
CBCS SCHEME

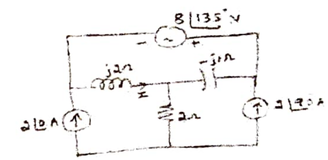
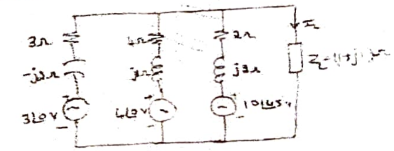
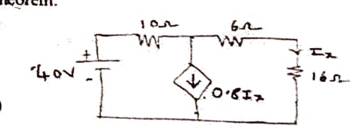
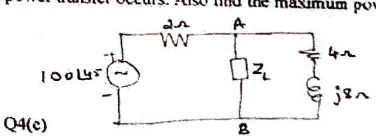
USN

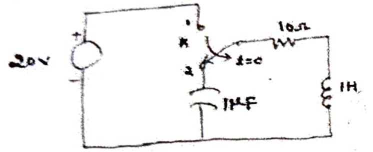
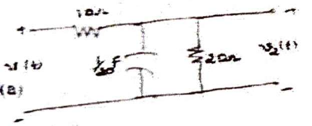
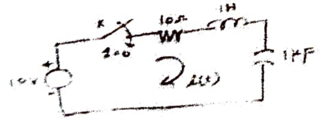
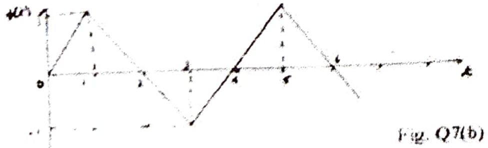
Third Semester B.E./B.Tech. Degree Examination, Dec.2023/Jan.2024
Network Analysis

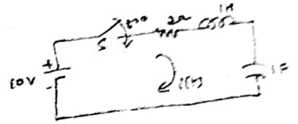
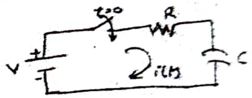
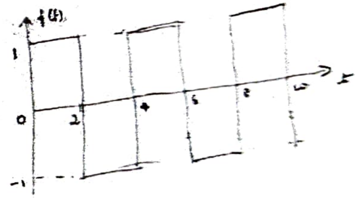
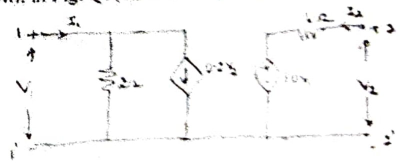
Time: 3 hrs. Max. Marks: 100

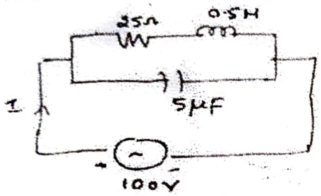
Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Explain the classification of electrical networks.	8	L2	CO1
	b.	For the network shown in Fig. Q1(b), find the current through load resistor 'R' using loop analysis.  Fig. Q1(b)	6	L3	CO1
	c.	For the network shown in Fig. Q1(c), find the equivalent resistance between the terminals A – B using Star – Delta transformation.  Fig. Q1(c)	6	L3	CO1
		OR			
Q.2	a.	Derive an expression for the equivalent impedances between the terminals for Delta – Star transformation.	6	L2	CO1
	b.	Use nodal analysis to find the value of voltage 'V_x' in the circuit shown in Fig. Q2(b), such that the current through $(2 + j3)\Omega$ impedance is zero.  Fig. Q2(b)	7	L3	CO1
	c.	Determine the current through 12Ω resistor shown in Fig. Q2(c), using Source Shifting / Transformation method.  Fig. Q2(c)	7	L3	CO1

		Module – 2			
Q.3	a.	Using Superposition theorem, obtain the current 'I' for the network shown in Fig. Q3(a).  Fig. Q3(a)	10	L2	CO1
	b.	Using Millman's theorem, calculate the current through the load in the circuit shown in Fig. Q3(b).  Fig. Q3(b)	10	L3	CO2
		OR			
Q.4	a.	State and explain Norton's theorem.	6	L2	CO2
	b.	For the network shown in Fig. Q4(b), find the current through 16Ω resistor using Thevenin's theorem.  Fig. Q4(b)	7	L3	CO2
	c.	For the network shown in Fig. Q4(c), find the value of Z_L for which maximum power transfer occurs. Also find the maximum power.  Fig. Q4(c)	7	L3	CO2
		Module – 3			
Q.5	a.	Explain the initial and final conditions in basic elements.	6	L2	CO3

Q. No.		Question	Marks	L	CO
	b.	For the circuit shown in Fig. Q5(b), the switch 'K' is changing the position from 1 to 2 at $t = 0$. Steady state condition has been reached at position 1. Find the value of i, $\frac{di}{dt}$, $\frac{d^2i}{dt^2}$ at $t = 0^+$.  Fig. Q5(b)	8	L3	CO3
	c.	Obtain an expression for transient response i(t) of a series R – L circuit when excited by DC supply.	6	L2	CO3
		OR			
Q.6	a.	In the circuit shown in Fig. Q6(a), $v_1(t) = e^{-t}$ for $t \geq 0$ and zero for all $t < 0$. If the capacitor is initially uncharged, determine the value of $v_2(t)$, $\frac{dv_2(t)}{dt}$, $\frac{d^2v_2(t)}{dt^2}$ and $\frac{d^3v_2(t)}{dt^3}$ at $t = 0^+$.  Fig. Q6(a)	10	L3	CO3
	b.	For the circuit shown in Fig. Q6(b), the switch is closed at $t = 0$. Determine i, $\frac{di}{dt}$, $\frac{d^2i}{dt^2}$ and $\frac{d^3i}{dt^3}$ at $t = 0^+$.  Fig. Q6(b)	10	L3	CO3
		Module – 4			
Q.7	a.	State and prove Initial Value Theorem.	6	L2	CO3
	b.	Find the Laplace Transform of the periodic waveform shown in Fig. Q7(b).  Fig. Q7(b)	8	L3	CO3

Q. No.		Question	Marks	L	CO
	c.	Using Laplace transform, determine the current i(t) in the circuit shown in Fig. Q7(c), when the switch 'S' is closed at $t = 0$. Assume zero initial conditions.  Fig. Q7(c)	6	L3	CO3
		OR			
Q.8	a.	State and prove differentiate by 'S' domain property.	6	L2	CO3
	b.	In the circuit shown in Fig. Q8(b), the switch is closed at $t = 0$. Obtain the expression for the current.  Fig. Q8(b)	6	L3	CO3
	c.	Obtain the Laplace Transform of the square wave shown in Fig. Q8(c).  Fig. Q8(c)	8	L3	CO3
		Module – 5			
Q.9	a.	What are Impedance and Hybrid parameters? Derive the expression for the same.	8	L2	CO4
	b.	Derive an expression for Transmission parameters interms of Z - parameters.	5	L2	CO4
	c.	For the circuit shown in Fig. Q9(c), find Y - parameters.  Fig. Q9(c)	[illegible]	L3	CO4
		OR			
Q.10	a.	Derive an expression for bandwidth of a series Resonant circuit	[illegible]	L2	CO5

	b.	A series RLC circuit consists of a resistance of 1 kΩ and an inductance of 100mH in series with capacitance of 10PF connected across 100V supply. Determine i) Resonant frequency ii) Quality factor iii) Maximum current in the circuit iv) Bandwidth v) Half power frequencies v) Selectivity factor.	7	L3	CO5
	c.	For the circuit shown in Fig. Q10(c), find i) Resonant frequency ii) Quality factor iii) Bandwidth iv) Impedance at resonance v) Current at resonance.  Fig. Q10(c)	6	L3	CO5

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Network Analysis - Dec.2023/Jan.2024.

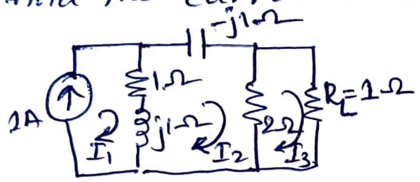
Q1.a. Explain the classification of Electrical Network.

Ans: Classification of Electrical Network.

(i) Linear network.
(ii) Non- Linear network
(iii) Active network
(iv) Passive network
(v) Unilatral network
(vi) Bilatral network
(vii) Lumped network.
(viii) Distributed network.

$8 \times 1 = 8M.$

Q1.b. Find the current through load resistor 'R_L' using loop analysis.



1M

From fig. $I_1 = 2A$.

Loop 2 ⇒ KVL Eqn is $\quad -3I_2 + 2I_3 = -(1+j) \longrightarrow ①$ $\quad$ 2M

Loop 3 ⇒ KVL Eqn is $\quad 2I_2 - 3I_3 = 0 \longrightarrow ②$ $\quad$ 2M

Solving Eqn ① & ②.

$$\begin{bmatrix} -3 & 2 \\ 2 & -3 \end{bmatrix} \begin{bmatrix} I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -(1+j) \\ 0 \end{bmatrix}$$

2M

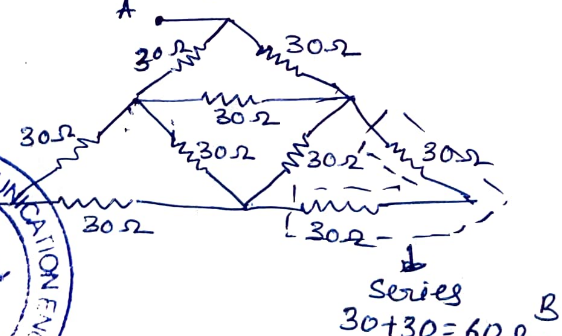
$I_3 = \dfrac{\Delta_3}{\Delta}$ where $\Delta = \begin{vmatrix} -3 & 2 \\ 2 & -3 \end{vmatrix} = 5$

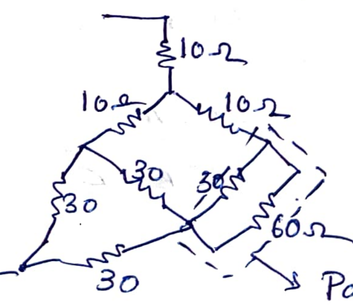
$\Delta_3 = \begin{vmatrix} -3 & -(1+j) \\ 2 & 0 \end{vmatrix} = 2(1+j)$

$I_3 = \dfrac{2(1+j)}{5} = \boxed{0.567 \angle 45 \ A}$ $\quad$ 1M.

Q1 c. Find the Equivalent resistance between the terminal A-B using Star-Delta transformation.

Step① - Convert upper delta- Star.





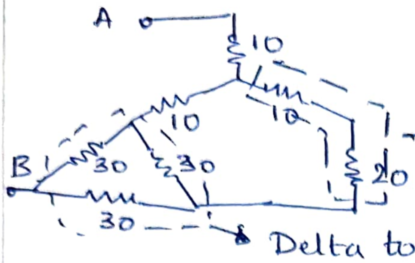
$R_1 = \dfrac{30 \times 30}{30+30+30}$

$R_1 = 10\Omega$

$R_1 = R_2 = R_3 = 10\Omega$

$R = \dfrac{30 \times 60}{30+60} = 20\Omega$

2M



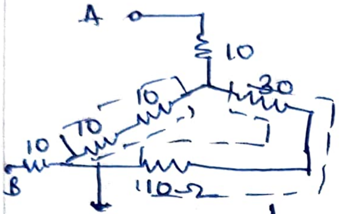
→ series $10+20=30\Omega$.

→ Delta to star.–

$R_1 = \frac{30 \times 30}{30+30+30} = 10$.

$R_1 = R_2 = R_3 = 10\Omega$.

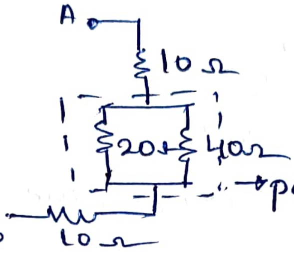
2M



Series $10+10=20\Omega$

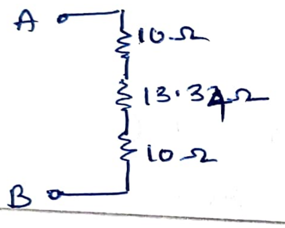
Series $30+10=40\Omega$.

⇒

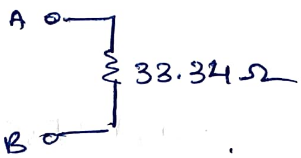


→ parallel, $R = \frac{20 \times 40}{20+40} = 13.33$.

2M.

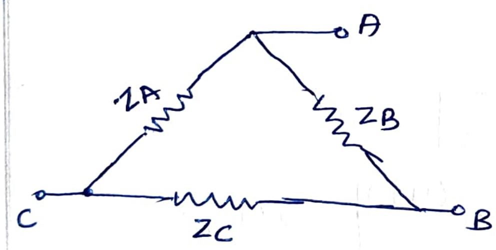


⇒

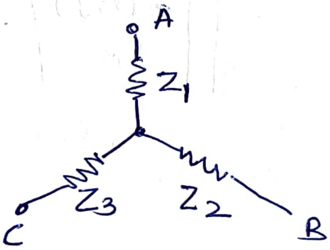


Q2.a. Derive an expression for equivalent impedance between the terminals for Delta to star transformation.

Ans



⇒



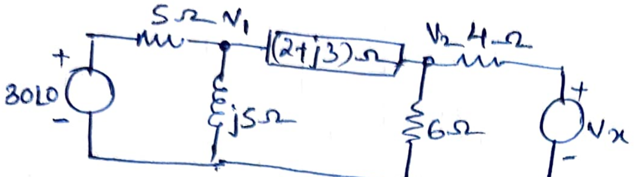
$Z_1 = \frac{Z_A Z_B}{Z_A+Z_B+Z_C}$

$Z_2 = \frac{Z_B Z_C}{Z_A+Z_B+Z_C}$

& $Z_3 = \frac{Z_C Z_A}{Z_A+Z_B+Z_C}$

(06M)

Q2 b. Use nodal analysis to find value of voltage 'V_x' in the circuit shown. such that current through $(2+j3)\Omega$ impedance is zero.



At node 1. ⇒ KCL Eqn is. $-\dfrac{(V_1 - 30\angle 0)}{5} - \dfrac{V_1}{j5} = 0$ 02 M.

$V_1 = 21.21\angle 45\, V$ ⟶ 01 M.

At node 2 ⇒ KCL Eqn is $\dfrac{0 - V_2}{6} - \dfrac{V_2 - V_x}{4} = 0.$

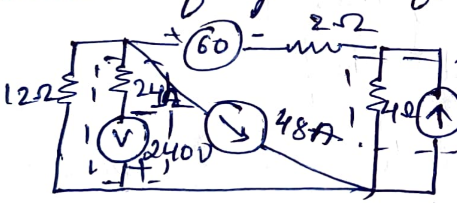
⇒ $0.416V_2 - 0.25V_x = 0$ 02 M.

Since $I_3 = 0$. $V_1 = V_2$ $V_2 = V_1 = 21.2\angle 45$ ⟶ 01 M.

$V_x = 1.667\,(21.2\angle 45)$

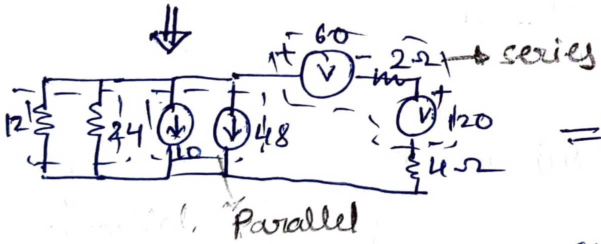
⇒ $\boxed{V_x = 35.33\angle 45\, V.}$

Q2 c. Determine the current through 12Ω resistor shown, using source shifting / Transformation method.

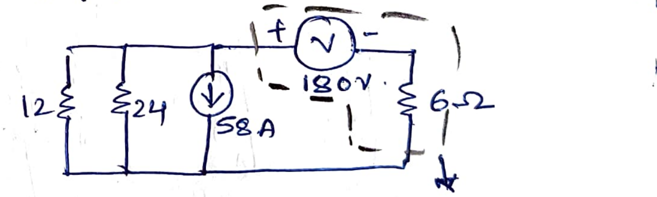


Step ① Converting voltage source to current source, & 30A current source to voltage source

$I = \dfrac{240}{24\Omega} = 10A.$ $V = 30 \times 4 = 120V.$ -02M

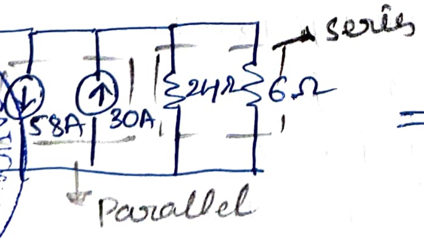


⇒

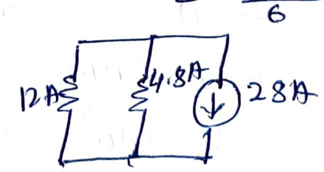


Step ② convert 180V voltage source to current source. -02M

$I = \dfrac{180}{6} = 30A.$



⇒

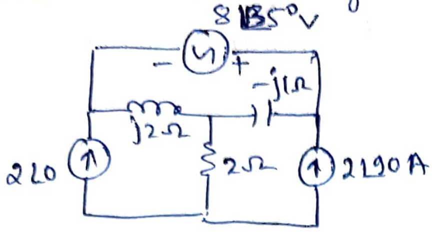


$I_{12\Omega} = \dfrac{28 \times (4.8\Omega)}{4.8 + 12\Omega}$

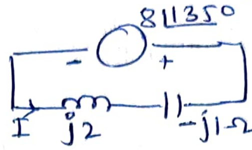
$\boxed{I_{12} = 8A}$ -01M

(4)

Q3 a. Find current "I" using superposition Theorem.



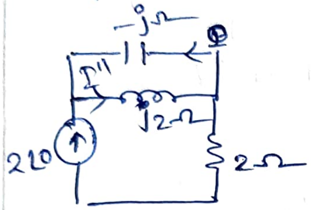
Step ① − Consider $8\angle 135°$, open circuit $2\angle 0$ A & $2\angle 90$ A.



$$I' = \frac{-8\angle 135°}{j1} = 8\angle 225\,A$$

$$\boxed{I' = -5.65 - j5.65\,A}$$

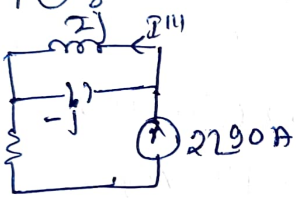
Step ② Consider $2\angle 0$ A, S.C $8\angle 135°$ & O.C. $2\angle 90$ A. 03M



$$I'' = \frac{2\angle 0(-j1)}{2j - j1} \Rightarrow \boxed{I'' = -2A}$$

03M

Step ③ Considers $2\angle 90$ A, S.C $8\angle 135°$ & O.C. $2\angle 0$ A.



$$I''' = \frac{2\angle 90)(-j)}{2j - j} = -2j\,A. \Rightarrow \boxed{I''' = -2j\,A}$$

03M

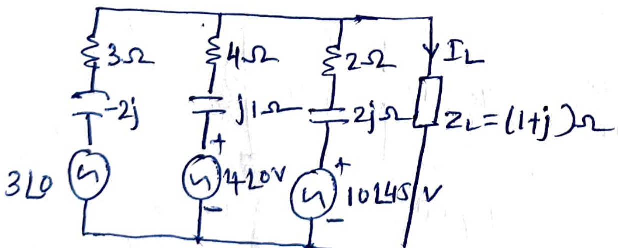
$$I = I' + I'' + I''' \Rightarrow -5.65 - j5.65 - 2A - 2jA.$$

$$I = -7.65 - j7.65$$

$$\boxed{I = 10.82\angle -135\,A}$$

01M

Q3 b. Using Millman's theorem, calculate current through the load in the circuit.



Finding I_L using Millman's Theorem,

$Z_1 = 3 - j2 \Rightarrow Y_1 = 0.277\angle 33.69 = 0.2304 + j0.153675$ ℧

$Z_2 = 4 + j1 \Rightarrow Y_2 = 0.2425\angle -14.03 = 0.235 - j0.058$ ℧

$Z_3 = 2 + j2 \Rightarrow Y_3 = 0.353\angle -45 = 0.25 - j0.25$ ℧

$Y_m = Y_1 + Y_2 + Y_3 = 0.7156 - j0.155 = 0.732\angle -12.33$ ℧ 02M

$Zm = \frac{1}{Ym} = \frac{1}{0.732 \angle -12.23} = 1.365 \angle 12.23 \, \Omega$ 01M

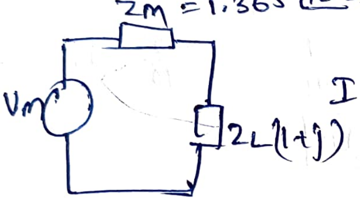
$V_1 Y_1 = 0.6914 + j0.4609$

$V_2 Y_2 = 0.941 + j0.235$

$V_3 Y_3 = 3.536 + j0$ 03M.

$Vm = \frac{V_1 Y_1 + V_2 Y_2 + V_3 Y_3}{Y_1 + Y_2 + Y_3} = \frac{5.173 \angle 2.5}{0.732 \angle -12.23}$ 02M.

$\boxed{Vm = 7.065 \angle 14.73 \, V}$ 01M



$I = \frac{Vm}{Zm + ZL} = \frac{7.065 \angle 14.73}{1.365 \angle 12.23 + (1+j)}$

$\boxed{I_L = 2.649 \angle -14.17 \, A}$ 01M

Q4a. State and Explain Norton's theorem.

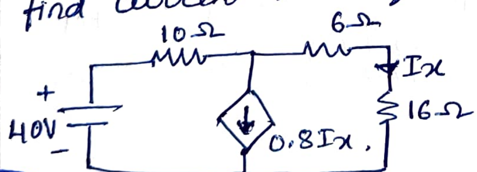
Ans Statement of Norton's theorem –

Norton's theorem state that a linear two terminal circuit can be replaced by equivalent circuit consisting of a current source I_N in parallel with a resistor R_N where I_N is the short-circuit current through the terminals and R_N is the input or equivalent resistance at the terminals when the independent source are turn-off.

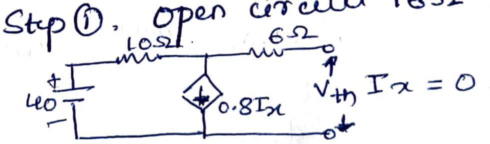
02M.

Explination 04M

Q4.b. find current through 16Ω resistor using Thevenin's theorem.

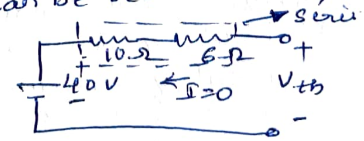


Step ①. open circuit 16Ω resistor.



$Ix = 0$.

Can be redrawn as,

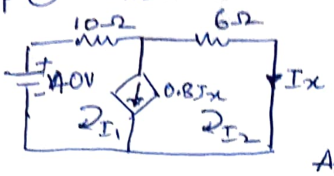


$Req = 10 + 6 = 16\Omega$

$\boxed{V_{th} = 40V}$

– 02M

Step ② Short circuit 16Ω Resistor.



$I_1 - I_2 = 0.8 I_x$

Since $I_x = I_2$

$I_1 - 1.8 I_2 = 0 \rightarrow ①$.

Apply KVL to outer loop.

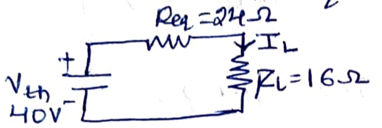
$-10 I_1 - 6 I_2 + 40 = 0 \rightarrow ②$.

Solving Eqn ① & ② $I_1 = 3A$ & $I_2 = 1.67$.

$\boxed{I_x = 1.67A}$ 02M

$Req = \frac{V_{TH}}{I_{sc}} = \frac{40Ω}{1.67A} = 24Ω$. ——— 01M

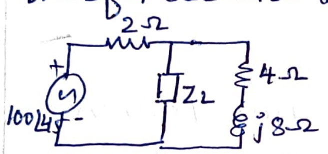
Step ③ Thevenin's Equivalent circuit



$I_L = \frac{V_{TH}}{Req + R_L} = \frac{40}{24+16} = \frac{40}{40} = 1A$

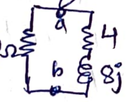
$\boxed{I_L = 1A}$ 02M

Q4 c. For the given networks, find the value of Z_L for which maximum power transfer occurs. Also find the maximum power.



For Pmax $Z_L = Zeq^*$.

to find Zeq.



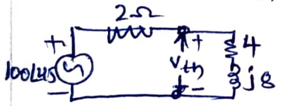
$Zeq = 2 \| (4+j8)$

$= \frac{2(4+j8)}{2+4+j8}$

$Zeq = (1.76 + j0.32)$. 02M.

$Z_L = Zeq^* = 1.76 - j0.32$ 02M

Find the Pmax, find VTH.



Applying KVL to the loop.

$-2I - 4I - j8I + 100\angle 45 = 0$

$I = 10\angle{-8.13}$ A 02M

$V_{TH} = I(4+j8) = 10\angle{-8.13}\,(4+j8)$

$\boxed{V_{TH} = 89.44\angle 55.3\ V}$ 01M

$P_{max} = \frac{V_{TH}^2}{4R_L} = \frac{(89.44)^2}{4(1.76)} = 1136.29W \rightarrow$ 01M.

Q5 a. Explain the initial & final condition of Element.

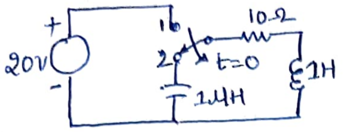
(i) Resistor → t = 0+ & t = ∞ both are same.

(ii) Capacitor → t = 0+ open circuit, t = ∞ to close; t = 0+ zero voltage, t = ∞ peak value. t = 0+ same continues, t = ∞ same continue } close circuit to open

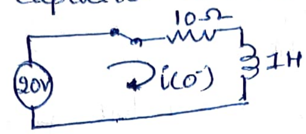
(iii) Inductor → t = 0+, t = ∞ } open circuit to close; t = 0+ zero current, t = ∞ peak, t = 0+ + conducting, t = ∞ − continue } close to open

06M

Q5 b. For the circuit shown, the switch 'K' is changing the position from 1 to 2 at $t=0$. Steady State condition has been reached at position 1. Find the value of i, $\frac{di}{dt}$, $\frac{d^2 i}{dt^2}$ at $t=0^+$



Switch Position at 1
Inductor act as short circuit.
Capacitor act as open circuit.

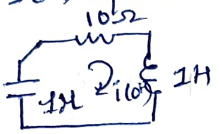


$i(0^-) = \frac{20}{10} = 2A.$ — 02M

$i(0^+) = i(0^-) = 2A$

$V_C(0^-) = V_C(0^+) = 0V.$ — 02M.

when switch position at 2,
for $t \geq 0$, equivalent circuit



Apply KVL to the loop.

$R i(t) + L\frac{di(t)}{dt} + \frac{1}{C}\int i(t)\,dt = 0 \rightarrow (1)$ — 02M.

At $t=0^+$

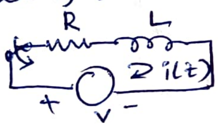
$\frac{di(0^+)}{dt} = -20A/sec.$ — 02M.

differentiate Eqn (1) with t.

$R\frac{di(t)}{dt} + L\frac{d^2 i(t)}{dt^2} + \frac{i(t)}{C} = 0.$

$t=0^+$ $\quad \frac{\partial^2 i(t)}{dt^2} = 2\times10^6 A/sec.$ — 02M

Q5 c. Obtain an expression for transient response $i(t)$ of a series R-L circuit when excited by DC supply.



At $t=0^-$

$i(0^-) = i(0^+) \Rightarrow I_0 = 0A$

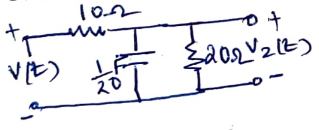
At $t=0^+$, when switch is closed.

$-R i(t) - L\frac{d(i)}{dt} + V = 0$

$V = R i(t) + L\frac{di(t)}{dt}$

on solving Eqn $\quad i(t) = \frac{V}{R} - \frac{V}{R} e^{-R/L\, t}$ — 06M.

Q6 a. In the circuit shown, $V(t) = e^{-t}$ for $t \geq 0$ and zero for all $t<0$. if the capacitor is uncharged, determined the value of $V_2(t)$, $\frac{dV_2(t)}{dt}$, $\frac{d^2V_2(t)}{dt^2}$ & $\frac{d^3 V_2(t)}{dt^3}$ at — 01M



Since capacitor is initialy uncharged,

$V_2(0^+) = 0.$

Applying KCL at node V_2,

$\frac{V_2(t) - V(t)}{10} + C\frac{dV_2(t)}{dt} + \frac{V_2(t)}{2} = 0 \Rightarrow 0.15 V_2(t) + 0.05\frac{dV_2(t)}{dt} = 0.1e^{-t} \rightarrow (1)$ — 03M

At $t=0^+$ $\quad 0.15V_2(0^+) + 0.05\frac{dV_2(0^+)}{dt} = 0.$

$\frac{\partial V_2(0^+)}{dt} = 2V/sec$ — 02M

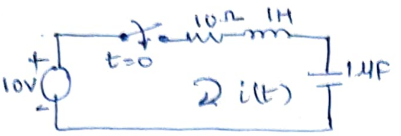
differentiate Eqn (1) w.r.t 't' $\quad 0.15\frac{dV_2(t)}{dt} + 0.05\frac{\partial^2 V_2(t)}{dt^2} = 0.1e^{-t}$

At $t=0^+$ $\quad \frac{d^2 V_2(t)}{dt^2} = 8V/sec^2$ — 02M

At $t=0^+$ $\quad \frac{d^3 V_2(t)}{dt^3} = 26V/sec^3$ — 02M

(8)

Q6 b. For the circuit shown, the switch is closed at $t=0$, Determine $i, \frac{di}{dt}, \frac{d^2i}{dt^2}$ & $\frac{d^3i}{dt^3}$ at $t=0^+$.



The switched 'K' is open. at $t=0^-$ & closed at $t=0^+$.

Since there is no current through Inductor $i(0^+)=0A$

At $t=0^+$ Apply KVL $-Ri(t) - L\frac{di(t)}{dt} - \frac{1}{C}\int_0^t i(t)\,dt$

$$-Ri(t) + L\frac{di(t)}{dt} + V_c(t) = 10$$

at $t=0^+$ $$2\,i(0^+) + \frac{\partial i(0^+)}{dt} + V_c(t) = 10 \rightarrow ①$$

$$\frac{di(0^+)}{dt} = 10\,A/sec.$$

Differentiating Eq② $$R\frac{di(t)}{dt} + L\frac{d^2i(t)}{dt} + \frac{1}{C}i(t) = 0.$$

at $t=0^+$ $R\frac{di}{dt} + 1\frac{d^2i}{dt^2}$ $\Rightarrow t=0^+$,

Q7 a. State and Prove Initial value theorem.

Statement: $\lim_{t\to 0^+} f(t) = \lim_{s\to\infty} sF(s) = f(0^+)$

where $F(s)$ is laplace transform of $f(t)$.

Proof: W.K.T.

$$L[f'(t)] = sL[f(t)] - f(0) = sF(s) - f(0)$$

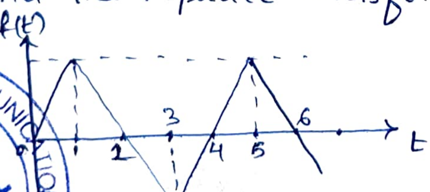
$\therefore sF(s)$

$$= L[f'(t)] + f(0)$$
$$= \int_0^\infty e^{-st} f'(t)\,dt + f(0)$$

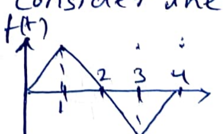
taking limit as $s\to\infty$ on both sides. we have

$$\lim_{s\to\infty} sF(s) = \lim_{s\to\infty}\left[\int_0^\infty e^{-st} f'(t)\,dt + f(0)\right]$$
$$= \int_0^\infty \lim\left[e^{-st} f'(t)\,dt + f(0)\right]$$
$$= 0 + f(0)$$
$$= f(0) \text{ // proved.}$$

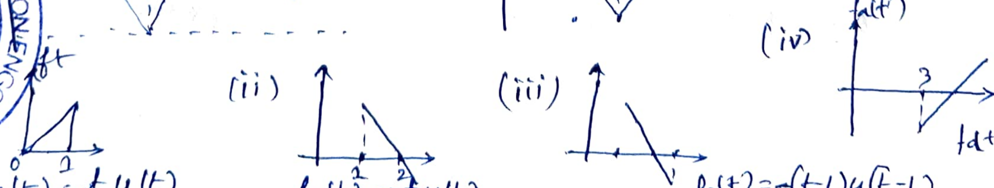
Q7 b. Find the Laplace transform of the periodic waveform shown



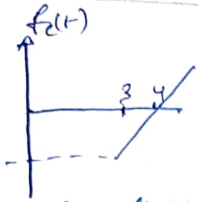
Consider the first cycle of the waveform



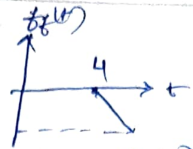
$T=4\,sec$



$f_a(t) = t\,u(t)$ $f_b(t) = -t\,u(t)$ $f_c(t) = -(t-1)u(t-1)$ $f_d(t) = (t-3)u(t-3)$

(v) 

$f_e(t) = (t-3)u(t-3)$

(vi) 

$f_f(t) = -(t-4)u(t-4)$

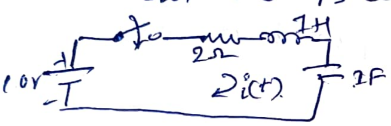
$$f(t) = f_a(t) + f_b(t) + f_c(t) + f_d(t) + f_e(t) + f_f(t)$$
$$= \cancel{d}\,u(t) - (t-1)u(t-1) - (t-1)u(t-1) + (t-3)u(t-3) + (t-3)u(t-3) - (t-4)u(t-4).$$

$$F_1(s) = \frac{1}{s^2}\left[1 - 2e^{-s} + 2e^{-3s} - e^{-4s}\right]$$

$$F(s) = \frac{1}{1-e^{-Ts}} F_1(s)$$

$$= \frac{1}{1-e^{-4s}}\left[\frac{1-2e^{-s}+2e^{-3s}+e^{-4s}}{s^2}\right]$$

Q 7c. Using Laplace transform, determine the current $i(t)$ in the circuit, where the switch 'S' is closed at $t=0$. Assume zero initial condition.



Apply KVL to the loop.

$$-2i(t) - (1)\frac{di(t)}{dt} - \frac{1}{1}\int i(t)\,dt + 100 = 0 \qquad \text{— 02M}$$

$$\Rightarrow 2i(t) + \frac{di(t)}{dt} + \int i(t)\,dt = 100.$$

taking Laplace Transfor

$$2I(s) + sI(s) + \frac{I(s)}{s} = \frac{100}{s}$$

$$I(s)\left(2 + s + \frac{1}{s}\right) = \frac{100}{s}$$

$$I(s) = \frac{100}{(s+1)^2} \qquad \text{03M}$$

$$\boxed{i(t) = 100\,t\,e^{-t}} \qquad \text{01M.}$$

Q 8a. State and Prove differentiate by 'S' domain property.

Statement: The differentiation in frequency domain or s-domain property of Laplace transform states that the multiplication of the function by 't' in time domain results in the differentiation in the s-domain. Therefor if

$$x(t) \xrightarrow{LT} X(s).$$

then $$t\,x(t) \xrightarrow{LT} -\frac{d}{ds}X(s).$$

Proof: $$L[x(t)] = X(s) = \int_0^\infty x(t)\,e^{-st}\,dt.$$

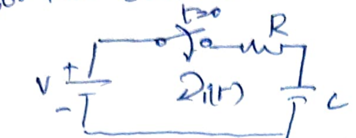
$$\frac{d}{ds}X(s) = \frac{d}{ds}\left[\int_0^\infty x(t)\,e^{-st}\,dt\right]$$

$$= \int_0^\infty -t\,x(t)\,e^{-st}\,dt = L[-t\,x(t)]$$

$$\therefore L[t\,x(t)] = -\frac{d}{ds}X(s) \quad //$$

10

Q8b. In the circuit shown. the switch is closed at $t=0$, obtain the expression for the current.



Before closing the switch,
There was no charges in the capacitor ; $V_c(0^-) = 0V$

After closing the switch, Apply KVL to the loop.

$$R\,i(t) + \frac{1}{C}\int_{\infty}^{t} i(t)\,dt = V$$

$$\Rightarrow R\,i(t) + \frac{1}{C}\int_{\infty}^{0^-} i(t)\,dt + \frac{1}{C}\int_{0^-}^{t} i(t)\,dt = V$$

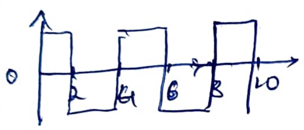
taking Laplace Transform.

$$I(s)\,R + \frac{1}{sC} I(s) + \frac{V(0^-)}{s} = \frac{V}{s}$$

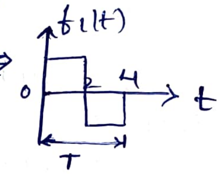
$$I(s) = \frac{(V/R)}{s + 1/RC}$$

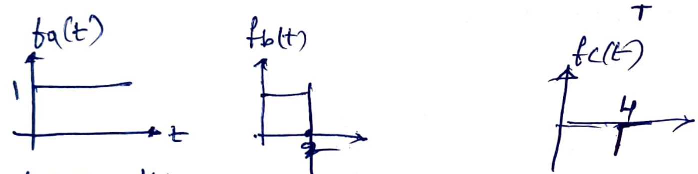
$$i(t) = \left(\frac{V}{R}\right) e^{-(1/RC)t}$$

Q8 c. Obtain the Laplace transform of the square wave shown in the fig.



$T = 4\,sec$, $\Rightarrow$





03 M

$f_a(t) = u(t)$ $\quad f_b(t) = -2u(t-2)$ $\quad f_c(t) = u(t-4)$

$f(t) = f_a(t) + f_b(t) + f_c(t)$ 01 M

$= u(t) + (-2)\,u(t-2) + u(t-4)$

$F_1(s) = 1/s + \frac{2e^{-s}}{s} + \frac{1}{s}e^{-4s}$ 01 M

$F(s) = \frac{1}{1-e^{-Ts}} F_1(s)$

$F(s) = \frac{1}{1-e^{-4s}}\left[\frac{1 - 2e^{-s} + e^{-4s}}{s}\right]$ 02 M.

Q9 a. What are Impedance & Hybrid Parameters ? Derive the expression for the same.

Ans Impedance → or Z-parameters represents relation between voltage & current at each port of the network.

$Z_{11} = \frac{V_1}{I_1}$, $Z_{12} = \frac{V_1}{I_2}$, $Z_{21} = \frac{V_2}{I_1}$, $Z_{22} = \frac{V_2}{I_2}$ 03M

Hybrid parameters → H-parameters, the combinations of spacing and amplitude parameter, voltage and current ration.

$h_{11} = \frac{V_1}{I_1}$, $h_{12} = \frac{V_1}{V_2}$, $h_{21} = \frac{I_2}{I_1}$, $h_{22} = \frac{I_2}{V_2}$ 03M

Q9 b. Derive expression for Transmission parameters interms of Z-parameters.

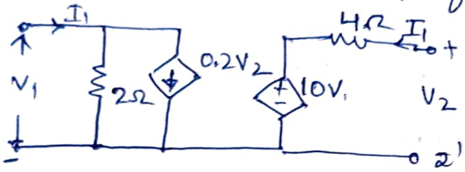
→ $[T] = V_1 = AV_2 + B(-I_2)$ & $[Z] = V_1 = Z_{11}I_1 + Z_{12}I_2$

$I_1 = CV_2 + D(-I_2)$ $V_2 = Z_{21}I_1 + Z_{22}I_2$

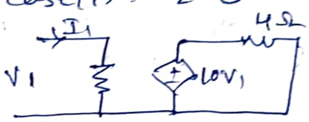
$$[T] \text{ interms of } [Z] = \begin{bmatrix} Z_{11}/Z_{21} & \dfrac{Z_{11}Z_{22} - Z_{12}Z_{21}}{Z_{21}} \\ 1/Z_{21} & Z_{22}/Z_{21} \end{bmatrix}$$

05M

Q9 c. For the circuit shown, find Y-Parameters.



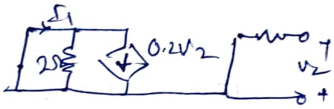
case(i) : $V_2 = 0$



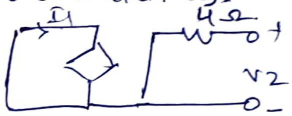
$V_1 = 2I_1$

$Y_{11} = \frac{I_1}{V_1} = \frac{1}{2} = 0.5\,\mho$ 02M

case(ii)



where 2Ω is Redundant. hence circuit will be rewritten as.



$I_1 = 0.2V_2$.

$Y_{12} = \frac{I_1}{V_2} = 0.2\,\mho$

& $V_2 = 4I_2$

$Y_{22} = \frac{I_2}{V_2} = \frac{1}{4} = 0.25\,\mho$

Apply KVL to loop2

$-4I_2 - 10V_1 = 0$

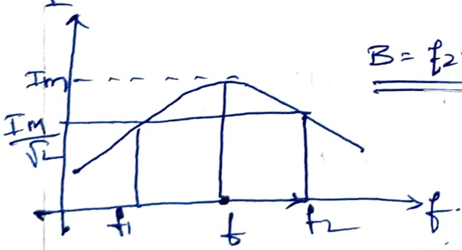
$Y_{21} = \frac{I_2}{V_1} = \frac{-10}{4} = -2.5\,\mho$.

$$[Y] = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} 0.5 & 0.2 \\ -2.5 & 0.25 \end{bmatrix}$$

03M.

Q10 a. Derive an expression for Bandwidth of a series Resonant circuit.

→ Band width : The range of frequencies between these two cut-off frequencies i.e $(f_2 - f_1)$ is called as Band width of the resonant circuit.



$B = f_2 - f_1$

half power frequencies. (3 dB frequencies)

$$\frac{1}{\sqrt{2}} \cdot \frac{V}{R} = \frac{V}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}}$$

$$\left(\omega L - \frac{1}{\omega C}\right)^2 = R^2$$

$$\boxed{\omega L - \frac{1}{\omega C} = \pm R}$$

Inductive reactance = capacitive reactance

$X_L = X_C$

$\omega L = \frac{1}{\omega C}$

$2\pi f L = \frac{1}{2\pi f C}$.

$f^2 = \frac{1}{4\pi^2 LC}$

$f = \sqrt{\frac{1}{4\pi^2 LC}}$

$f_r = \frac{1}{2\pi\sqrt{LC}}$

or $f_0 = \sqrt{f_1 f_2}$

$$\boxed{(f_2 - f_1) = \frac{R}{2\pi L}}$$

Q 10 b. A series RLC circuit of a resistance of 1KΩ and an inductance of 100mH. in series with capacitance of 10PF connected accross 100V supply.
Determine: i) Resonant frequency ii) Quality factor iii) Maximum current in the circuit iv) Bandwidth v) Halfpower frequencii
v) selectivity factor.

i) Resonant frequency ⇒ $f_0 = \frac{1}{2\pi\sqrt{LC}} = 159.23 KHz$

ii) Quality factor ⇒ $Q_0 = \frac{1}{R}\sqrt{L/C} = 100$

iii) Bandwidth ⇒ $(f_2 - f_1) = \frac{R}{2\pi L} = 1.592 KHz$

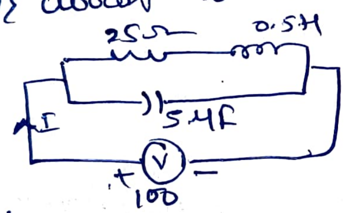
iv) Maximum Current ⇒ $I_0 = \frac{V}{R} = 0.1A$.

v) Halfpower frequencies $f_1 = f_0 - \Delta f = 158.43 KHz$

$f_2 = f_0 + \Delta f = 160.02 KHz$

07M.

Q 10 c. For the circuit shown, find i) Resonant frequency. ii) Quality factor. iii) Band width iv) Impedance at Resonance v) current at resonance,



i) Resonance frequency $= f_r = \frac{1}{2\pi}\left[\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}\right] = 100.39 Hz$

ii) Quality factor. $Q_0 = \frac{\omega_{ar} L}{R} = 12.60$

iii) Bandwidth ⇒ $\frac{f_{ar}}{Q_0} = 7.96 Hz$

iv) Impedance at Resonance $Z_{or} = \frac{L}{CR_L} = 4000\Omega$.

v) Current at Resonance $I_0 = \frac{V}{Z_{ay}} = 0.025A$ //

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