University of Mumbai
Examination 2021 under Cluster 06
(Lead College: Vidyavardhini's College of Engg Tech)

Examination Commencing from 15th June 2021

Program: **Electronics Engineering**

Curriculum Scheme: Rev 2019

Examination: SE Semester III

Course Code: ELC304 and Course Name: Electrical Network Analysis and Synthesis

Time: 2 hour Max. Marks: 80

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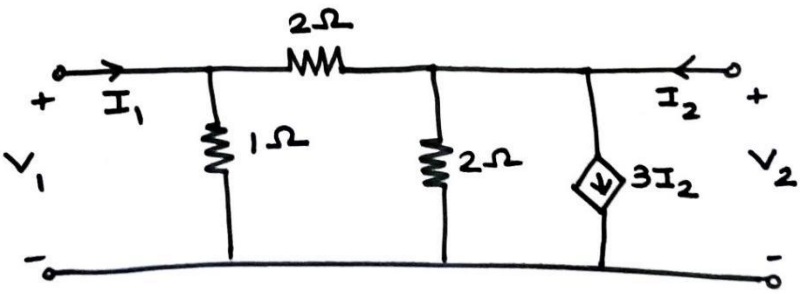
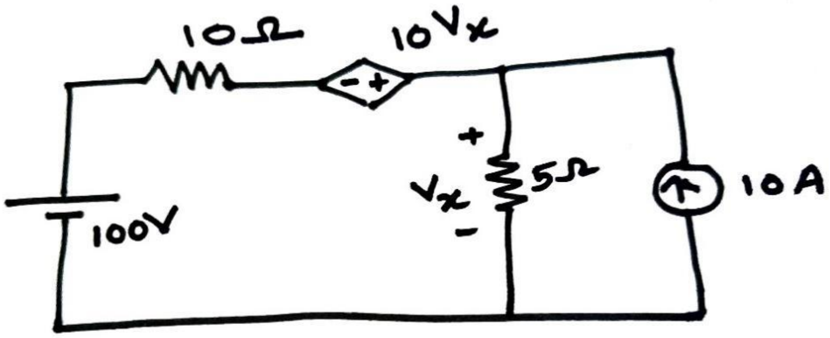
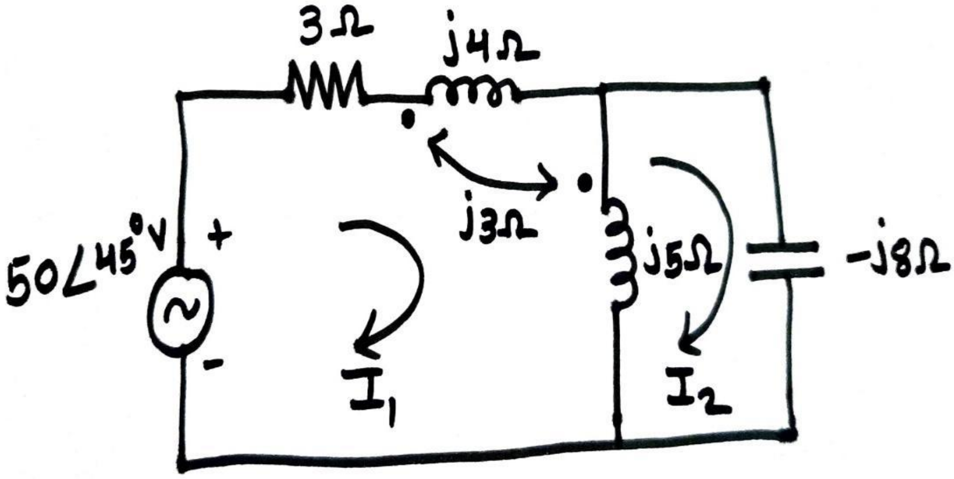
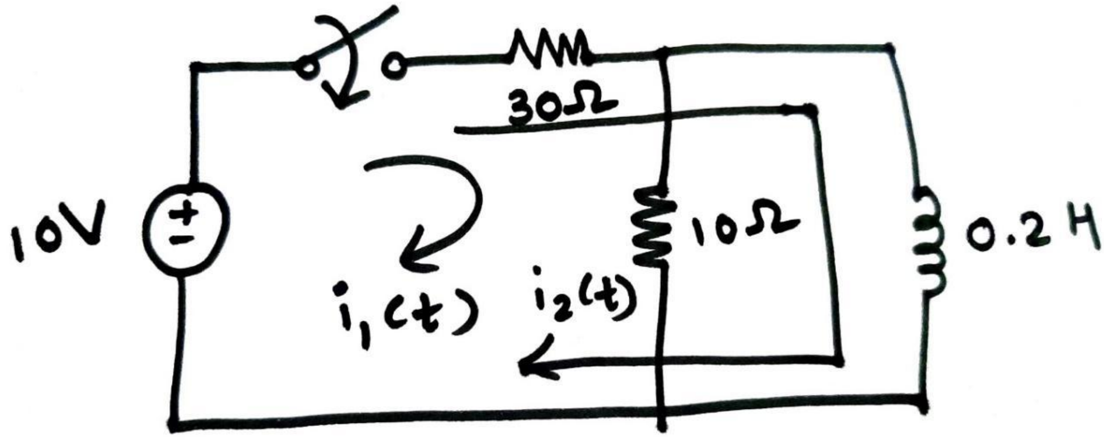
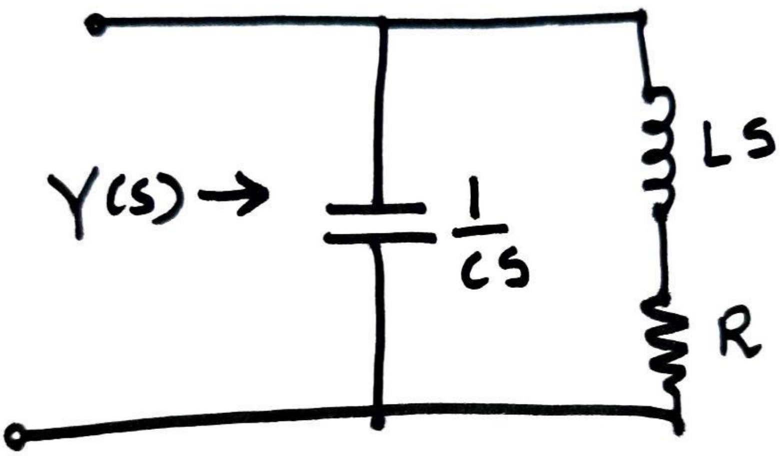
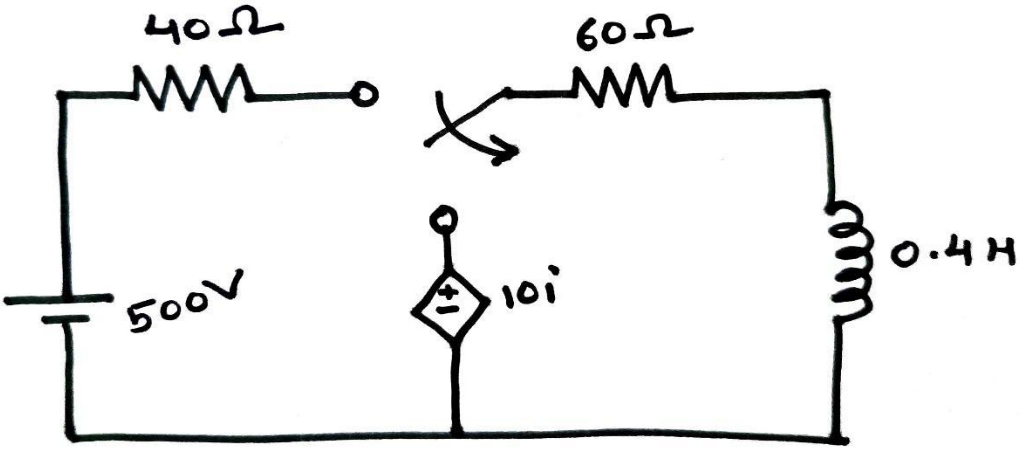
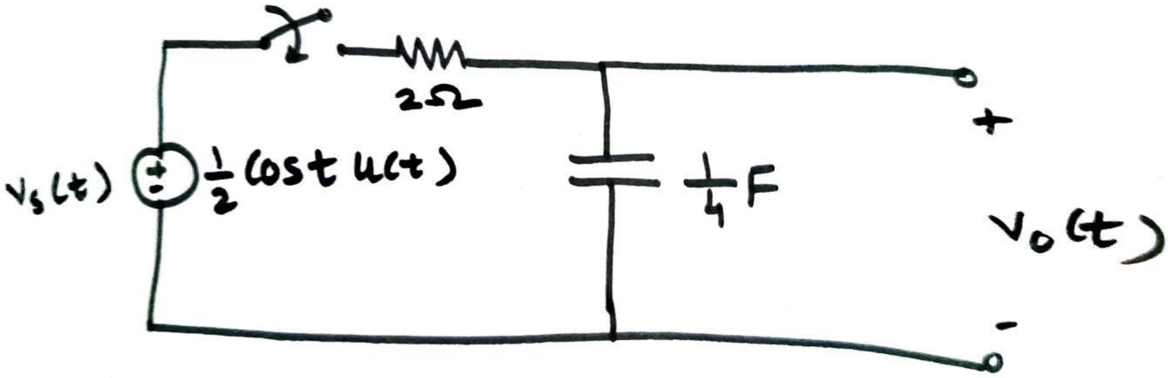
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	According to Kirchhoff's voltage law, the algebraic sum of all IR drops and e.m.fs. in any closed loop of a network is always
Option A:	Negative
Option B:	Positive
Option C:	Determined by battery e.m.fs.
Option D:	Zero
2.	A dependent source
Option A:	May be a current source or a voltage source
Option B:	Is always a voltage source
Option C:	Is always a current source
Option D:	Neither a current source nor a voltage source
3.	For determining the polarity of a voltage drop across a resistor, it is necessary to know the
Option A:	Value of resistor
Option B:	Value of current
Option C:	Direction of current flowing through the resistor
Option D:	Value of e.m.f. in the circuit
4.	In superposition theorem, when we consider the effect of one voltage source, all the other voltage sources are
Option A:	Shorted
Option B:	Opened
Option C:	Removed
Option D:	Undisturbed
5.	Thevenin resistance is found by
Option A:	Shorting all voltage sources
Option B:	Opening all current sources
Option C:	Shorting all voltage sources and opening all current sources
Option D:	Opening all voltage sources and shorting all current sources
6.	For magnetically coupled circuits, $M = K*\sqrt{(L1*L2)}$, where K represents

Option A:	Inductance
Option B:	Coefficient of coupling
Option C:	Reluctance
Option D:	Constant
7.	A capacitor with initial voltage zero, what will be equivalent circuit at t=0+
Option A:	Open circuit
Option B:	Short Circuit
Option C:	Voltage source
Option D:	Current source
8.	A inductor with initial current Io, what will be equivalent circuit at $t=\infty$
Option A:	Short circuit
Option B:	Open circuit
Option C:	Short circuit across current source
Option D:	open circuit in series with voltage source
9.	A step function voltage is applied to an RLC series circuit having R=2Ω , L=1H and C=1 F. The Transient response would be
Option A:	over damped
Option B:	under damped
Option C:	Undamped
Option D:	critically damped
10.	The transient currents are due to
Option A:	resistance of the circuit
Option B:	impedance of the circuit
Option C:	voltage applied to the circuit
Option D:	charges stored in inductors and capacitor
11.	The necessary and sufficient condition for a rational function F(s) to be the driving-point impedance of an RC network is that all poles and zeros should be
Option A:	complex and lie in the left half of s-plane
Option B:	simple and lie on the negative real axis in the s-plane
Option C:	complex and lie in the right half of s-plane
Option D:	simple and lie on the positive real axis of the s-plane
12.	As the poles of a network shift away from the x-axis, the response
Option A:	Remains constant
Option B:	becomes less oscillating
Option C:	become more oscillating
Option D:	No oscillation
13.	A Two-port resistive network satisfy the condition A = D = (3/2)B = (4/3)C. Find the value of Z11 for the network
Option A:	4/3
Option B:	3/4
Option C:	2/3
Option D:	3/2

14.	Which of the following ABCD parameters is unit less?
Option A:	A and D
Option B:	A and B
Option C:	B and C
Option D:	A and C
15.	An RC driving -point impedance function has zeros at S=-2 and S=-5.The admissible poles for the function would be
Option A:	S=0,S=-6
Option B:	S=0,S=-1
Option C:	S=-3,S=-4
Option D:	S=-1,S=-3
16.	Determine the range of 'k' so that $P(s)=s^3+3s^2+2s+k$ is Hurwitz
Option A:	$0 < k < 6$
Option B:	$0 < k < 5$
Option C:	$1 < k < 0$
Option D:	$k > 0$
17.	The passband of typical filter network with Z1 and Z2 as the series and shunt-arm impedance is characterized by
Option A:	-1 <z1/4z2<0
Option B:	-1 <z1/4z2<1
Option C:	0 <z1/4z2<1
Option D:	z1/4z2 > 0
18.	Find the value of Inductor for Constant K Low Pass "T" Section, if cutoff frequency is 4KHz and nominal characteristic impedance is 500ohm
Option A:	39.79mH
Option B:	29.79mH
Option C:	19.9mH
Option D:	29.9mH
19.	The Cauer - II form is obtained by
Option A:	Continued Fraction Expansion about the pole at infinity
Option B:	Partial Fraction Expansion of the admittance function Y(S)
Option C:	Continued Fraction Expansion about the pole at origin
Option D:	Partial Fraction Expansion of the impedance function Z(S)
20.	If Z11 =10Ω, Z12=Z21=5Ω, Z22=20Ω. Find the value of Z1, Z2 and Z3 for the equivalent T-network
Option A:	Z1=5, Z2=5, Z3=15
Option B:	Z1=10,Z2=10,Z3=15
Option C:	Z1=5,Z2=10,Z3=15
Option D:	Z1=10,Z2=10,Z3=10

Q2 (20 Marks)	
A	**Solve any Two** **5 marks each**
i.	*For the Network shown in figure, find Z parameters.* 
ii.	*Find the current in the 10 Ω resistor using Thevenin's theorem.* 
iii.	Find the current through the capacitor using mesh analysis. 
B	**Solve any One** **10 marks each**

i.	*The switch in the network shown in figure is closed at t=0.Find V_2 (t) for all t>0.Assume zero initial current in the inductor.* 
ii.	*The network shown in figure has the driving- point admittance Y(s) of the form* $$Y(s) = H\frac{(s-s_1)(s-s_2)}{(s-s_3)}$$ *(a) Express s_1, s_2, s_3 in terms of R, L and C.* *(b) When $s_1=-10+j10^4$, $s_2=-10-j10^4$ and $Y(j0)=10^{-1}$ mho, Find the values of R, L and C and determine the value of S_3.* 
Q3 (20 Marks)	
A	**Solve any Two** **5 marks each**
i.	*Test whether the polynomial P(s) is Hurwitz.* $P(s) = S^5 + S^3 + S$

ii.	*For the network shown in figure. Find the current i(t) when the switch is changed from the position 1 to 2 at t=0.* 
iii.	Covert Y-parameter in terms of Hybrid parameter.
B	**Solve any One** **10 marks each**
i.	*Obtain the Cauer –I and Cauer –II forms of the RC impedance function.* $Z(s) = \frac{(S+2)\ (S+6)}{2(S+1)(S+3)}$
ii.	*Find the network shown in Figure, Find the response v_o (t).* 

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Q1:

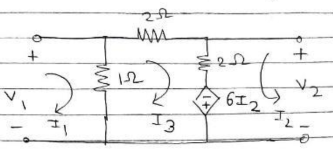
Question Number	Correct Option (Enter either 'A' or 'B' or 'C' or 'D')
Q1.	D
Q2.	A
Q3.	C
Q4	A
Q5	C
Q6	B
Q7	B
Q8.	C
Q9.	D
Q10.	D
Q11.	B
Q12.	C
Q13.	A
Q14.	A
Q15.	D
Q16.	A
Q17.	A
Q18.	C
Q19.	C
Q20.	A

2(A):

Q:-2

A)

i) The network is redrawn by source transformation.



KVL to mesh 1,

$V_1 = I_1 - I_3$ ---- (i)

KVL to mesh 2,

$V_2 = 2(I_2 + I_3) - 6I_2$

$= -4I_2 + 2I_3$ ---- (ii)

KVL to mesh 3,

$-(I_3 - I_1) - 2I_3 - 2(I_2 + I_3) + 6I_2 = 0$

$5I_3 = I_1 + 4I_2$

$I_3 = \frac{1}{5}I_1 + \frac{4}{5}I_2$ ---- (iii)

Substituting Eq. (iii) in Eq (i)

$V_1 = I_1 - \frac{1}{5}I_1 - \frac{4}{5}I_2 = \frac{4}{5}I_1 - \frac{4}{5}I_2$

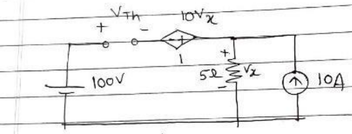
Substituting Eq. (iii) in eq. (ii)

$V_2 = -4I_2 + 2\left(\frac{1}{5}I_1 + \frac{4}{5}I_2\right)$

$= \frac{2}{5}I_1 - \frac{12}{5}I_2$

$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 4/5 & -4/5 \\ 2/5 & -12/5 \end{bmatrix}$

ii step I
Calculation of V_{Th}



$V_x = 50V$

$100 - V_{Th} + 10V_x - V_x = 0$

$100 - V_{Th} + 9V_x = 0$

$100 - V_{Th} + 9(50) = 0$

$V_{Th} = 550V$

Step II
Calculation of I_N

$V_x = 5(I_N + 10)$

KVL to mesh 1,

$100 + 10V_x - V_x = 0$

$V_x = -\frac{100}{9}$

$\therefore I_N = -\frac{550}{45}$ A

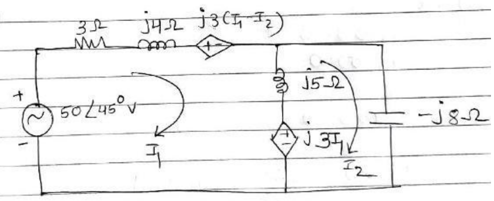
Step III Calculation of R_{Th}

$R_{Th} = -45\,\Omega$

Step IV Calculation of I_L

$I_L = \frac{550}{-45+10} = -\frac{110}{7}$ A

iii)



KVL to mesh1,

$(3+j15)I_1 - j8I_2 = 50\angle 45^\circ$ — (i)

KVL to mesh2,

$-j8I_1 - j3I_2 = 0$ — (ii)

$\begin{bmatrix} 3+j15 & -j8 \\ -j8 & -j3 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 50\angle 45^\circ \\ 0 \end{bmatrix}$

$I_2 = \frac{\begin{vmatrix} 3+j15 & 50\angle 45^\circ \\ -j8 & 0 \end{vmatrix}}{\begin{vmatrix} 3+j15 & -j8 \\ -j8 & -j3 \end{vmatrix}}$

$I_2 = 3.66\angle -310.33^\circ$ A

B)

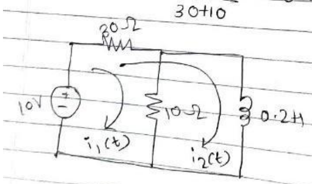
i) At $t = 0^-$

$i_1(0^-) = 0$

$i_2(0^-) = 0$

$i_2(0^+) = 0$

$i_1(0^+) = \frac{10}{30+10} = 0.25$ A



$10 - 30(i_1+i_2) - 10i_1 = 0$

and

$10 - 30(i_1+i_2) - 0.2\frac{di_2}{dt} = 0$

$i_1 = \frac{10-30i_2}{40} = 0.25 - 0.75i_2$

$\frac{di_2}{dt} + 37.5i_2 = 2.5$

$P = 37.5,\ Q = 2.5$

$i_2(t) = e^{-Pt}\int Qe^{Pt}\,dt + Ke^{-Pt}$

$= 0.067 + Ke^{-37.5t}$

At $t=0$, $i_2(0) = 0$

$0 = 0.067 + K$

$K = -0.067$

$i_2(t) = 0.067 - 0.067e^{-37.5t}$

$V_2(t) = 0.2\frac{di_2}{dt}$

$= 0.2\frac{d}{dt}(0.067 - 0.067e^{-37.5t})$

$V_2(t) = 0.5e^{-37.5t}$ for $t>0$

ii) $Y(s) = Cs + \frac{1}{Ls+R} = \frac{(Ls+R)(s+1)}{Ls+R}$

$$= \frac{LCs^2 + RCs + 1}{Ls+R}$$

$$= \frac{C\left(s^2 + \frac{R}{L}s + \frac{1}{LC}\right)}{s + \frac{R}{L}}$$

$$Y(s) = \frac{H(s-s_1)(s-s_2)}{(s-s_3)}$$

$$s_1, s_2 = \frac{-\frac{R}{L} \pm \sqrt{\left(\frac{R}{L}\right)^2 - \frac{4}{LC}}}{2}$$

$$= -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$$

$$s_3 = -\frac{R}{L}$$

$$s_1 = -10 + j10^4$$

$$s_2 = -10 - j10^4$$

$$Y(s) = H\frac{(s+10-j10^4)(s+10+j10^4)}{s-s_3}$$

$$= H\frac{s^2 + 20s + 10^8}{s-s_3}$$

$$\frac{R}{L} = 20$$

$$s_3 = -20$$

$$Y(s) = H\frac{(s^2+20s+10^8)}{(s+20)}$$

At $s = j(0)$,

$$Y(j0) = H\frac{(10^8)}{20} = 10^{-1}$$

$$H = 0.02 \times 10^{-6}$$

$$Y(s) = 0.02 \times 10^{-6}\frac{(s^2+20s+10^8)}{(s+20)}$$

$$C = 0.02 \times 10^{-6}\ F = 0.02\ \mu F$$

$$\frac{1}{LC} = 10^8$$

$$L = \frac{1}{2} H$$

$$\frac{R}{L} = 20$$

$$R = 10\Omega$$

Q 3

(A)

i) $P(s) = s^5 + s^3 + s$

$P'(s) = \frac{d}{ds} P(s) = 5s^4 + 3s^2 + 1$

$Q(s) = \frac{P(s)}{P'(s)}$

$5s^4+3s^2+1 \,)\, s^5+s^3+s \,(\, \frac{1}{5}s$

$s^5 + \frac{3}{5}s^3 + \frac{1}{5}s$

$\frac{2}{5}s^3 + \frac{4}{5}s \,)\, 5s^4+3s^2+1 \,(\, \frac{25}{2}s$

$5s^4 + 10s^2$

$-7s^2+1 \,)\, \frac{2}{5}s^3 + \frac{4}{5}s \,(\, -\frac{2}{35}s$

$\frac{2}{5}s^3 - \frac{2}{35}s$

$\frac{26}{35}s \,)\, -7s^2+1 \,(\, -\frac{245}{26}s$

$-7s^2$

1

since quotient terms are negative, P(s) is not Hurwitz.

iii)

$V_1 = h_{11} I_1 + h_{12} V_2$

$I_2 = h_{21} I_1 + h_{22} V_2$

$I_1 = \frac{1}{h_{11}} V_1 - \frac{h_{12}}{h_{11}} V_2$

$I_1 = y_{11} V_1 + y_{12} V_2$

$y_{11} = \frac{1}{h_{11}}$

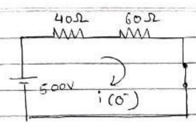
$y_{12} = \frac{-h_{12}}{h_{11}}$

$I_2 = h_{21} \left[\frac{1}{h_{11}} V_1 - \frac{h_{12}}{h_{11}} V_2 \right] + h_{22} V_2$

$y_{21} = \frac{h_{21}}{h_{11}}$

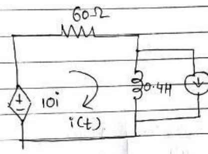
$y_{22} = \frac{h_{11}h_{22} - h_{12}h_{21}}{h_{11}} = \frac{\Delta h}{h_{11}}$

ii)



$i(0^-) = \frac{500}{40+60} = 5A$

$i(0^+) = 5A$



$10i - 60i = 0.4\frac{di}{dt} = 0$

$\frac{di}{dt} + 125i = 0$

$P = 125$

$i(t) = Ke^{-Pt} = Ke^{-125t}$

$K = 5$

$i(t) = 5e^{-125t}$ for $t>0$.

B

i) Cauer I

$Z(s) = \frac{s^2+8s+12}{2s^2+8s+6}$

By CFE

$2s^2+8s+6 \,)\, s^2+8s+12 \,(\, \frac{1}{2} \leftarrow Z$

s^2+4s+3

$4s+9 \,)\, 2s^2+8s+6 \,(\, \frac{1}{2}s \leftarrow Y$

$2s^2 + \frac{9}{2}s$

$\frac{7}{2}s+6 \,)\, 4s+9 \,(\, \frac{8}{7} \leftarrow Z$

$4s + \frac{48}{7}$

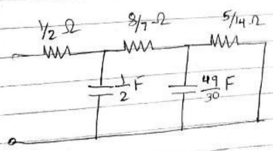
$\frac{15}{7} \,)\, \frac{7}{2}s+6 \,(\, \frac{49}{30}s \leftarrow Y$

$\frac{7}{2}s$

$6 \,)\, \frac{15}{7} \,(\, \frac{5}{14} \leftarrow Z$

$\frac{15}{7}$

0



ii) Cauer II

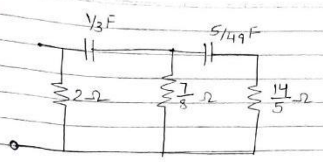
$$Z(s) = \frac{12+5s+s^2}{6+8s+2s^2}$$

By CFE

$$6+8s+2s^2 \overline{)\,12+8s+s^2\,}\,(2$$
$$\underline{12+16s+4s^2}$$
$$-8s-3s^2$$

$$Y(s) = \frac{6+8s+2s^2}{12+8s+s^2}$$

$$12+8s+s^2 \overline{)\,6+8s+2s^2\,}\,(\tfrac{1}{2} \leftarrow Y$$
$$\underline{6+4s+\tfrac{1}{2}s^2}$$
$$4s+\tfrac{3}{2}s^2 \overline{)\,12+8s+s^2\,}\,(\tfrac{3}{s} \leftarrow Z$$
$$\underline{12+\tfrac{9}{2}s}$$
$$\tfrac{7}{2}s+s^2 \overline{)\,4s+\tfrac{3}{2}s^2\,}\,(\tfrac{8}{7} \leftarrow Y$$
$$\underline{4s+\tfrac{8}{7}s^2}$$
$$\tfrac{5}{14}s^2 \overline{)\,\tfrac{7}{2}s+s^2\,}\,(\tfrac{49}{5s} \leftarrow Z$$
$$\underline{\tfrac{7}{2}s}$$
$$s^2 \overline{)\,\tfrac{5}{14}s^2\,}\,(\tfrac{5}{14} \leftarrow Y$$
$$\underline{\tfrac{5}{14}s^2}$$
$$0$$



ii) $V_s(s) = \frac{1}{2}\,\frac{s}{s^2+1}$

$$V_o(s) = V_s(s) \times \frac{4/s}{2+4/s} = \frac{2V_s(s)}{s+2} = \frac{s}{(s^2+1)(s+2)}$$

$$V_o(s) = \frac{As+B}{s^2+1} + \frac{C}{s+2}$$

$$s = (As+B)(s+2) + C(s^2+1)$$

$$s = (A+C)s^2 + (2A+B)s + (2B+C)$$

$A+C=0$

$2A+B=1$

$2B+C=0$

$A=0.4, \quad B=0.2, \quad C=-0.4$

$$V_o(s) = \frac{0.4s+0.2}{s^2+1} - \frac{0.4}{s+2}$$

$$v_o(t) = 0.4\cos t + 0.2\sin t - 0.4e^{-2t} \quad \text{for } t>0$$