Solution

Q.P. code 24590

Q.1. A.

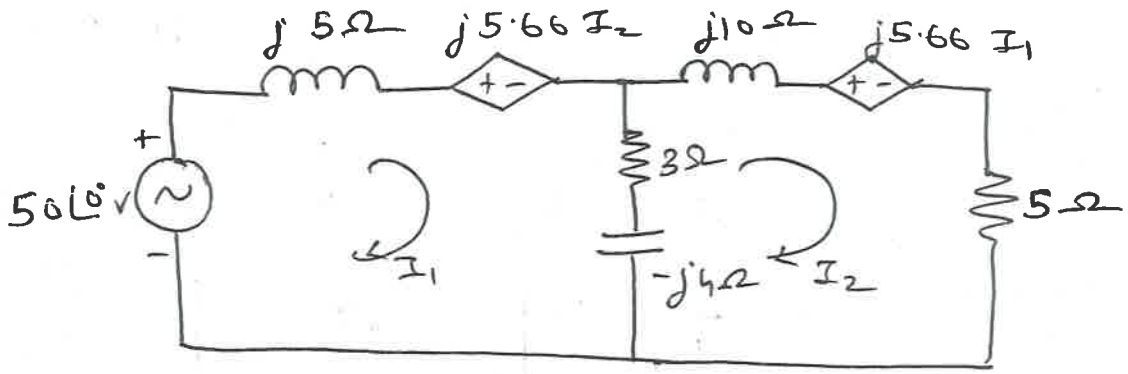
Soln

$$X_M = k\sqrt{X_{L_1} X_{L_2}}$$

$$= 0.8\sqrt{(5)(10)}$$

$$X_M = 5.66\ \Omega \qquad \text{(1 Mark)}$$

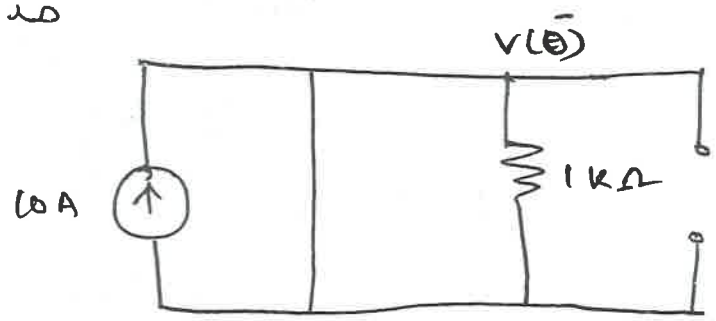
Equivalent circuit.



(4 marks)

B)

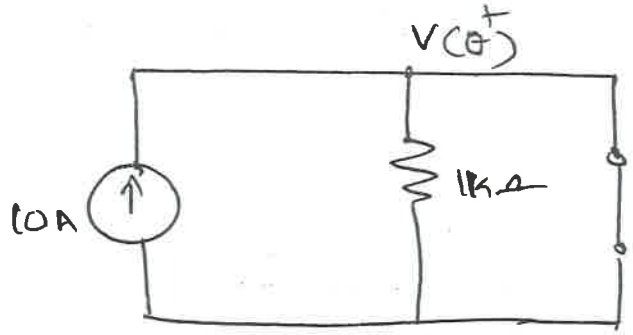
Soln at $t = 0^-$, the equivalent circuit is



$$V(0^-) = V_c(0^-) = 0\,V \qquad \text{(1 Mark)}$$

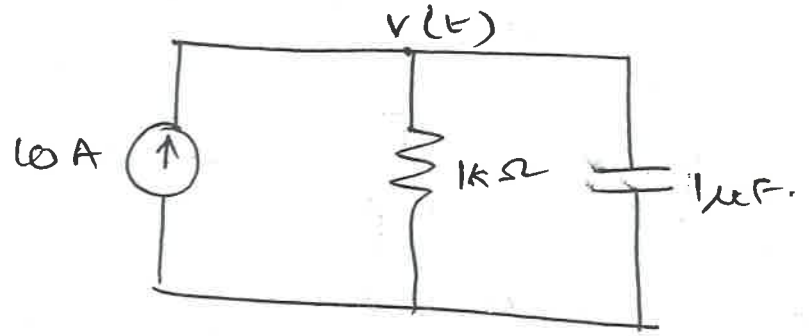
Q2

at $t = 0^+$, the equivalent circuit is



$V(0^+) = V_c(0^+) = 0\,V.$ (2 marks)

at $t > 0$, the equivalent circuit is



Applying KCL at the node

$$+10 - \left(\frac{v-0}{1k}\right) - C\frac{dv}{dt} = 0$$

$$\therefore 10 - \frac{v}{1000} - 1\mu\frac{dv}{dt} = 0. \quad \text{---} \quad (1)$$ (1 Mark)

at $t = 0^+$, eqn (1) becomes

$$10 - \frac{v(0^+)}{100} - 1\mu\frac{dv(0^+)}{dt} = 0$$

$$\therefore 1\mu\frac{dv(0^+)}{dt} = 10$$

$$\therefore \frac{dv}{dt}(0^+) = \frac{10}{1\mu} = 10\times10^6\ V/s.$$

(1 Mark)

03

1 c) (3)

1) Application of source at i/p with o/p s.c. (1 mark).
Obtain ratio of i/p voltage to o/p current

2) Application of source to o/p with i/p s.c.
Obtain ratio of o/p voltage to i/p current
(2 marks)

3) Apply condition for reciprocity and obtain the desired result (2 marks)

1 D) Each definition carries (1 mark) ✓

Q. 2

A) 1) Analysis at $t = 0^-$ with circuit. (2 marks)
$v_c(0^-) = 30V$, $i(0^-) = 0$.

2) Analysis at $t = 0^+$ with circuit (2 marks)
$v_c(0^+) = 30V$, $i(0^+) = -1A$. ✓

3) Analysis at $t > 0$ with circuit. (6 marks)

$$\frac{di}{dt}(0^+) = 0.33 \times 10^5 \text{ A/s}$$

$$\frac{d^2i}{dt^2}(0^+) = -1.1 \times 10^9 \text{ A/s}^2$$

04

Q.2 B. Soln

① Application of KVL to obtain mesh equations (4 marks)

② Writing Z parameters (2 marks)

③ $$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 4/5 & -4/5 \\ 2/5 & -12/5 \end{bmatrix}$$

④ Find Y-parameters using formulae otherwise. (2 marks)

⑤ Writing Y parameters (2 marks)

$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} 3/2 & -1/2 \\ 1/4 & -1/2 \end{bmatrix}$$

Q.3

A) 1) Application of KVL to write mesh equations for mesh ① – 3 marks.

2) Application of KVL to write mesh equation for mesh ② – 3 marks.

③ Mesh ③ current $I_3 = -1A$. (2 marks)

④ Finding currents I_x and I_y and I_1 and I_2 by solving simultaneous equations.
$I_1 = 2A$ $I_2 = 0A$. (2 marks)

05

(5)

3 B)

$R = 65\ \Omega/km \qquad L = 1.6\ mH/km$

$G = 2.25 \times 10^{-3}\ \mho/km \qquad C = 0.1\ \mu F/km.$

Soln

$$Z = R + j\omega L = 65 + j\,2\pi \times 1000 \times 1.6 \times 10^{-3}$$

$$= 65 + j\,10.05\ \Omega/km$$

$$= 65.77 \angle 8.78^\circ\ \Omega/km.$$

(2 marks)

$$Y = G + j\omega C = 2.25 \times 10^{-3} + j\,2\pi \times 1000 \times 0.1 \times 10^{-6}$$

$$= 2.25 \times 10^{-3} + j\,6.28 \times 10^{-4}$$

$$= 2.33 \times 10^{-3} \angle 15.59^\circ\ \mho/km$$

(2 marks)

(Characteristic Impedance) $Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{65.77 \angle 8.78^\circ}{2.33 \times 10^{-3} \angle 15.59^\circ}} = 168.01 \angle 3.405^\circ\ \Omega.$

(2 marks)

For Propagation constant

$$\gamma = \sqrt{ZY} = 0.391 \angle 12.19^\circ /km$$

(2 marks)

Attenuation constant $\alpha = 0.382 + j\,0.083/km$

0.382 nepers/km (1 mark)

Phase constant $\beta = 0.083$ rad/km

(1 mark)

06

(6)

4 A)

i) $F(s) = \frac{N(s)}{D(s)}$

ii) a) Prove the Numerator is Hurwitz and denominator has to be factorized to show ~~the~~ no poles lie on RHS of s-plane. (2marks) ~~Poles associated~~

b) Since poles lie on the jω axis, carry out the residue test. (1marks)

c) Find $A(\omega^2)$ and to see if $A(\omega^2) \geq 0$ for all ω, (1 mark)

d) Final comment on PRF (1mark)

B)

1) Calculation of V_{TH} (3 marks)

$V_{TH} = 75\,V$

2) Calculation of I_N (3 marks)

$I_N = 2A.$

3) Calculation of R_{TH} (2 marks)

$R_{TH} = 37.5\,\Omega.$

4) Thevenin's equivalent n/w. (2marks)

07

5) A) (7)

Soln

1) Break the network into two. (1 marks)

2) Write ~~KVL equations~~ KCL equations for network (1) (3 marks)

3) Write the Y-parameters for network(1).

$$\begin{bmatrix} Y_{11}' & Y_{12}' \\ Y_{21}' & Y_{22}' \end{bmatrix} = \begin{bmatrix} \frac{4s+1}{8s+4} & -\frac{1}{8s+4} \\ -\frac{1}{8s+4} & \frac{4s+1}{8s+4} \end{bmatrix}$$ (1 marks)

4) Write KCL equations for network (2) (3 marks)

5) Write Y-parameters for network (2) (1 marks)

$$\begin{bmatrix} Y_{11}'' & Y_{12}'' \\ Y_{21}'' & Y_{22}'' \end{bmatrix} = \begin{bmatrix} \frac{s(s+1)}{2s+1} & -\left(\frac{s^2}{2s+1}\right) \\ -\left(\frac{s^2}{2s+1}\right) & \frac{s(s+1)}{2s+1} \end{bmatrix}$$

6) Find Y-parameters of overall n/w. (1 mark)

$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} \frac{4s^2+8s+1}{4(2s+1)} & -\frac{4s^2+1}{4(2s+1)} \\ -\frac{(4s^2+1)}{4(2s+1)} & \frac{4s^2+8s+1}{4(2s+1)} \end{bmatrix}$$

5 (B) ~~Realization of~~

~~Realization of~~ $Y(s)$

a) Identification as LC function (2 marks)

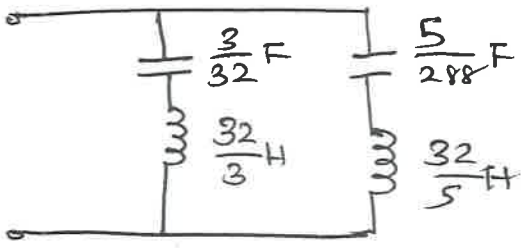
I) Foster II Realization

1) Partial Fraction expansion of Y(s) (2marks)

2) Finding the component values and drawing the circuit (2marks)

$L_1 = \frac{32}{3}H \quad C_1 = \frac{3}{32}F$

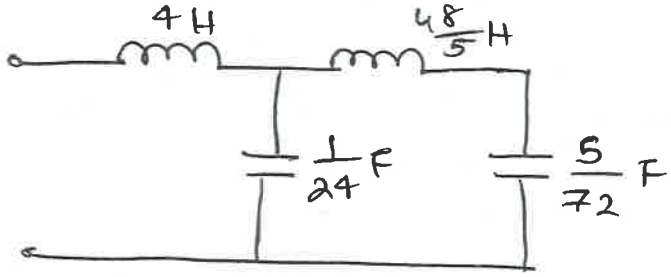
$L_2 = \frac{32}{5}H \quad C_2 = \frac{5}{288}F$



II Cauer I realization

1) Continued fraction expansion of Z(s) (2 marks)

2) Finding the component values and drawing the circuit (2marks)



Q6) A)

1) Find the normalized load impedance

$$\bar{Z}_L = \frac{25 + j50}{50} = 0.5 + j\ \Omega$$

(2marks)

2) Mark the normalized load impedance point A at the intersection of $r = 0.5$ circle and $x = 1$ circle. (1 mark)

3) Draw the VSWR circle with centre O and radius equal to distance OA. The VSWR circle cuts the horizontal axis at

09

$r = 4.2$ on the right hand side

$\therefore$ VSWR = 4.2. (2 marks)

4) Draw an arc with radius OA on the reflection coefficient line located at the lower side of the chart. This arc cuts the line at 0.62.

$\therefore |\Gamma| = 0.62$ (1 mark)

5) Extend line OA upto outer circumference of the chart to get point A'. The angle corresponding to A' is 83°.

$\therefore \phi = 83°$

$\Gamma = |\Gamma| \angle \phi = 0.62 \angle 83°$

(1 mark)

6) Find normalized input impedance

$\bar{Z}_s = 0.28 - j0.4.$ (2 marks)

7) Actual input impedance is

$Z_s = Z_0 \bar{Z}_s = 50(0.28 - j0.4)$

$= 14 - j20\ \Omega$ (1 mark)

6) B) Soln

10

(10)

1) Analysis at $t = 0^-$ (3 marks)

$i(0^-) = 1A$

$V_2(0^-) = 0$

2) Analysis at $t = 0^+$ (2 marks)

$i(0^+) = 1A$

$V_2(0^+) = -0.5V$

3) Analysis at $t > 0$

a) draw the equivalent circuit (1 mark)

b) Apply KCL to obtain node equation (1 mark)

c) Obtain differential equation of the form $\frac{dv}{dt} + Pv = 0$ (1 mark)

d) Find solution of the differential eqn. (2 marks)

$V_2(t) = -0.5 e^{-\frac{3}{4}t}$ for $t > 0$.