Q.2 b. Find I_1 and I_2 in Fig.2.

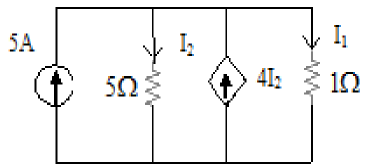
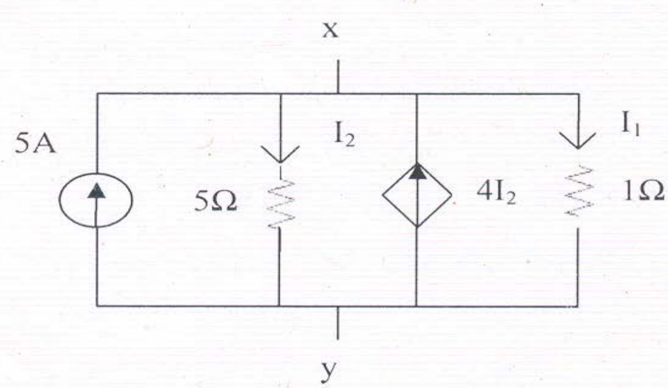


Fig.2

Answer:

Q. 2. (b) SOLUTION



Applying KCL at node x

$$I_2 + I_1 = 5 + 4I_2$$
$$I_1 - 3I_2 = 5$$
$$I_1 = \frac{v}{1} = v\ A \ \ and \ \ I_2 = \frac{v}{5}$$

From equation (1)

$$v = 12.5$$
$$I_1 = 12.5\ A \ \ and \ \ I_2 = 2.5\ A \qquad (Ans)$$

c. Obtain a single current source for the network shown in Fig.3.

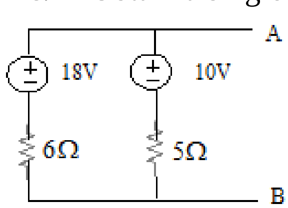
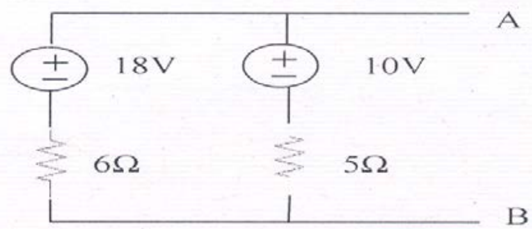


Fig.3

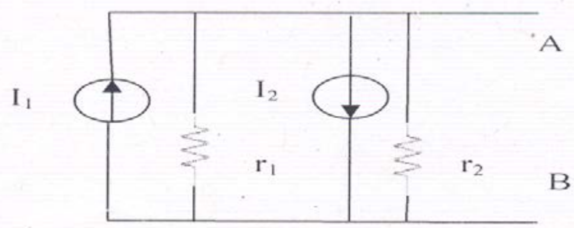
Answer:

Q. 2. (c) **SOLUTION**



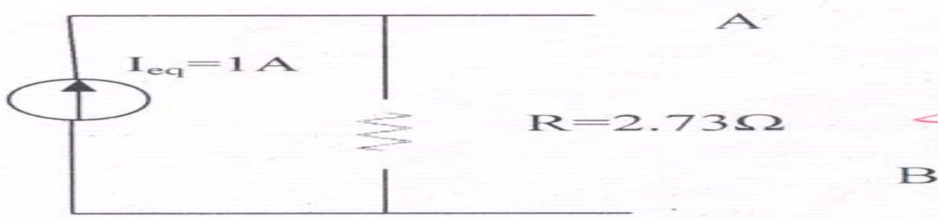
Convert the voltage source to current source

Here , $I_1=18/6=3A$, $I_2=10/5=2A$, $r_1=6\Omega$, $r_2=5\Omega$



$$I_{eq} = I_1 - I_2 = 1A$$

$$R = \frac{r_1 r_2}{r_1 + r_2} = \frac{6 \times 5}{6 + 5} = 2.73\Omega$$



Q.3 a. A D.C voltage of 100V is applied in the circuit as shown in Fig.4 with the switch K as open. Find the complete expression for the current i(t) after the switch k is closed at t = 0.

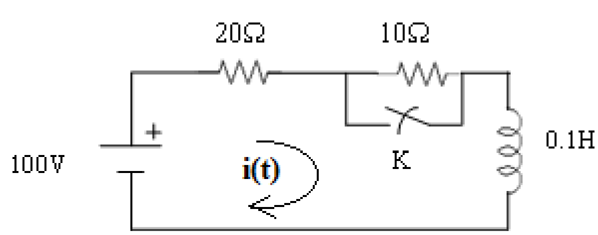
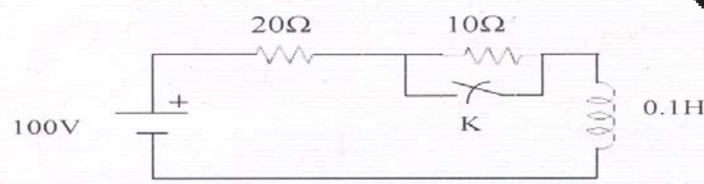


Fig.4

Answer:



Switch is closed at t=0, the mesh equation is

$$100 = 20i + 0.1\frac{di}{dt}$$

The complete solution is

$$i = i_c + i_p$$
$$i_c = Ce^{-200t}, \quad i_p = \tfrac{V}{R} = 5A$$
$$i = i_c + i_p$$
$$i = Ce^{-200t} + 5$$

Steady state current in the circuit is

$$i = \frac{v}{20+10} = \frac{100}{20+10} = 3.33A$$

Due to presence of inductor at t=0, i=3.33A

$$i = C + 5$$
$$C = -1.67$$
$$i = -1.67e^{-200t} + 5\ A \quad (Ans)$$

Q.4 a. Find the inverse Laplace transform of $I(s) = \dfrac{s+1}{s\left(s^2+4s+4\right)}$

Answer:

$$I(S) = \frac{s+1}{s(s^2+4s+4)}$$

$$I(S) = \frac{s+1}{s(s+2)^2}$$

$$I(S) = \frac{P}{s} + \frac{Q}{s+2} + \frac{R}{(s+2)^2}$$

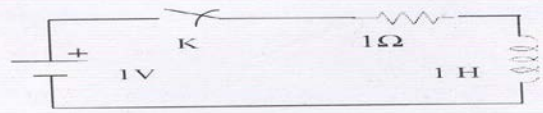
P=1/4 , Q= - 1/4 and R= 1/2

$$I(S) = \frac{1/4}{s} - \frac{1/4}{s+2} + \frac{1/2}{(s+2)^2}$$

$$i(t) = \frac{1}{4} - \frac{1}{4}e^{-2t} + \frac{1}{2}te^{-2t} \quad ($$

b. A series RL circuit is energized by D.C voltage of 1.0V by switching it at t=0. If R=1Ω and L=1H. Find the expression for the current in the circuit.

Answer:



$$Z(s) = R + sL$$

Assuming zero initial condition

$$Y(s) = \frac{1}{R + sL} = \frac{1}{L}\frac{1}{s + R/L}$$

Inverse Laplace transform

$$y(t) = \frac{1}{L}e^{-(R/L)t}$$

Convolution Integral

$$i(t) = y(t) * v(t) = \int_0^t y(t-\tau)v(\tau)d\tau$$

$$i(t) = \int_0^t \frac{1}{L}e^{-(R/L)(t-\tau)} . 1d\tau$$

Q.6 a. Test the following polynomial for the Hurwitz property.

$$P(s) = s^4 + 2s^3 + 4s^2 + 12s + 10$$

Answer:

$$P(S) = S^5 + 3S^4 + 3S^3 + 4S^2 + S + 1$$
$$P(S) = M(S) + N(S)$$

Where

$$M(S) = 3S^4 + 4S^2 + 1$$
$$N(S) = S^5 + 3S^3 + S$$

$$Z(S) = \frac{N(S)}{M(S)}$$

The given function Hurwitz Polynomial

b. Find the pole zero locations of the current transfer ratio I_2/I_1 in S-domain for circuit shown in Fig.6.

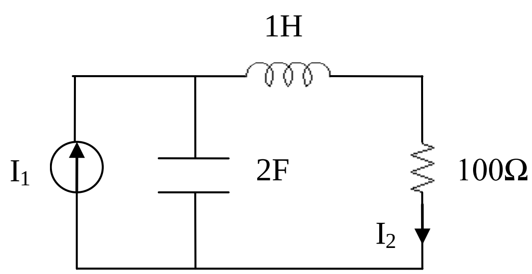
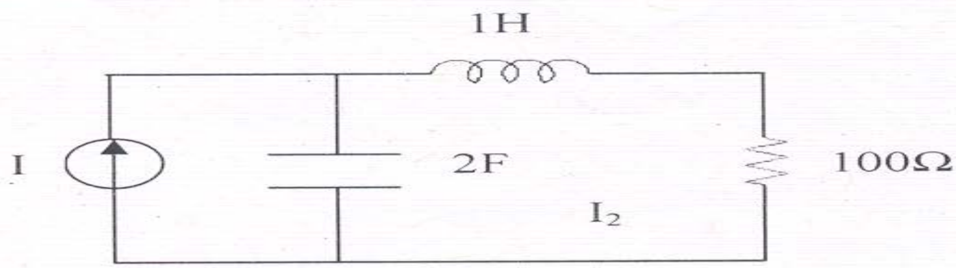
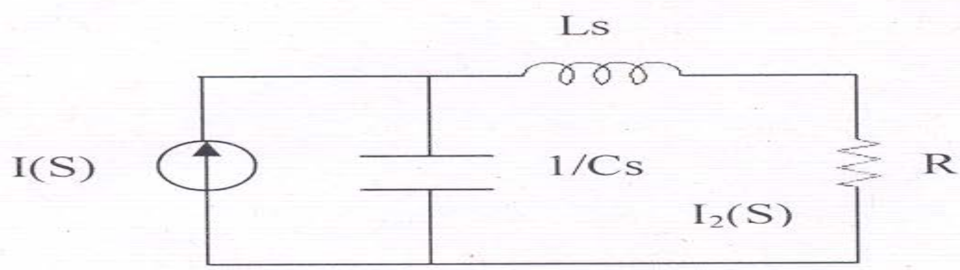


Fig.6

Answer:





$$I_2(s) = I_1(s)\frac{1/Cs}{R + Ls + 1/Cs}$$

$$\frac{I_2(s)}{I_1(s)} = \frac{1/Cs}{R + Ls + 1/Cs}$$

$$\frac{I_2(s)}{I_1(s)} = \frac{1}{1 + 200s + 2s^2}$$

$$s_1, s_2 = -100 \pm 99.99$$

$$s_1, s_2 = 0, -200 \quad (\textbf{Ans.})$$

Q.7 b. Find the open circuit parameters of the two port network shown in Fig.7.

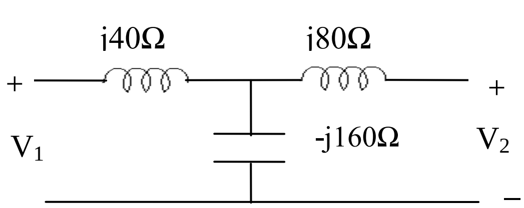
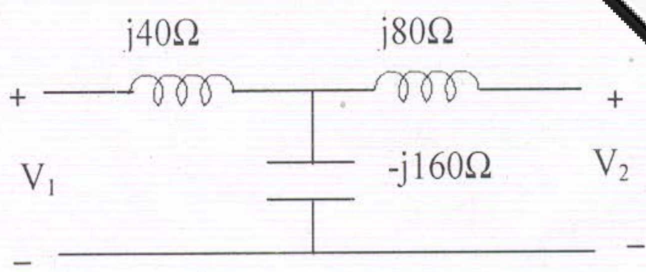


Fig.7

Answer:



Open circuit at the output terminals

$$V_1 = I_1 j(40 - 160)V$$

$$Z_{11} = \frac{V_1}{I_1} = -j120\,\Omega \quad (\boldsymbol{Ans})$$

$$V_2 = I_1 j(-160)V$$

$$Z_{21} = \frac{V_2}{I_1} = -j160\,\Omega \quad (\boldsymbol{Ans})$$

Similarly open circuit at the input terminals

$$V_2 = I_2 j(80 - 160)V$$

$$Z_{22} = \frac{V_2}{I_2} = -j80\,\Omega \quad (\boldsymbol{Ans})$$

$$V_1 = I_2 j(-160)V$$

$$Z_{12} = \frac{V_1}{I_2} = -j160\,\Omega \quad (\boldsymbol{Ans})$$

Q.8 b. The driving point impedance of a one port LC network is given by

$Z(s) = \dfrac{8(s^2+4)(s^2+25)}{s(s^2+16)}$ Obtain the foster form of equivalent network

Answer:

$$Z(S) = \frac{8(S^2+4)(S^2+25)}{S(S^2+16)}$$

The partial fraction expansion

$$Z(S) = \frac{A_0}{S} + \frac{A_2}{s+j4} + \frac{A_2^*}{s-j4} + H(s)$$

$$A_0 = \frac{8(S^2+4)(S^2+25)}{S(S^2+16)}$$

Put s=0

$$A_0 = \frac{8 \times 4 \times 25}{16} = 50$$

$$A_2 = \frac{8(S^2+4)(S^2+25)}{S(S-j4)}$$

Put s= -j4

$$A_2 = 27$$

$$H=8$$

In the first form of foster network

$$C_0 = \frac{1}{A_0} = \frac{1}{50}F$$

$$C_2 = \frac{1}{2A_2} = \frac{1}{54}F$$

$$L_\infty = H = 8H$$

$$L_2 = \frac{2A_2}{w_n^2} = 3.375H$$

The first form of foster network