

Task 1-A

$$j10 = j\omega L = j2\pi FL$$

$$\therefore L_1 = 1.5923 \text{ mH}$$

$$j5 = j\omega L \quad \therefore L_2 = 0.796 \text{ mH}$$

$$C_1 \rightarrow -j5 = \frac{1}{j\omega C} \quad \therefore C = 31.84 \text{ }\mu\text{F}$$

Simulated Results.

$$I = 141.319 \text{ mA rms}$$

$$V = 1.413 \text{ V rms.}$$

using Norton, Th(1) using Thevenin

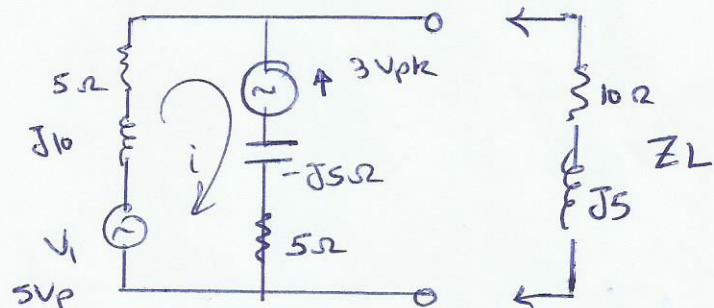
$$V_{Th} \Rightarrow$$

$$i = \frac{5-3}{5+5+j10-j5}$$

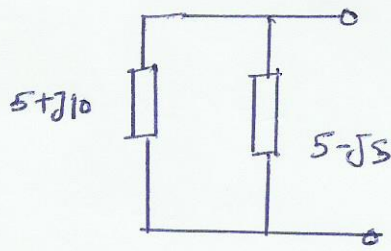
$$= 0.1788 \angle -26.56$$

$$V_{Th} = 5 - i(5+j10) = 5 - 0.1778 \angle -26.56 (11.18 \angle 63.43)$$

$$V_{Th} = 3.4 - j1.2 = 3.605 \angle -19.44$$



$R_{Th} (Z_{Th})$



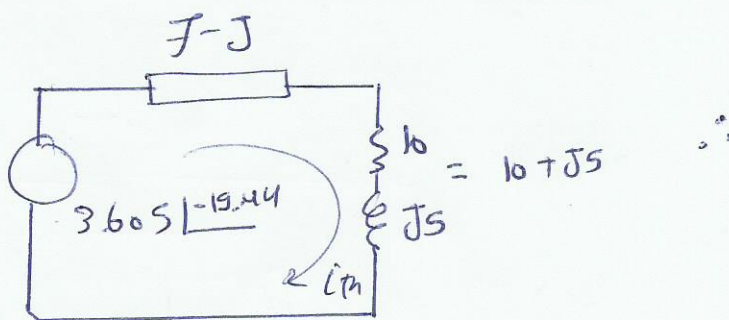
$$\underline{Z_{Th}} = \underline{R_{Th}} = (5 + j10) // (5 - j5) = \frac{(5 + j10)(5 - j5)}{5 + j10 + 5 - j5}$$

$$= \underline{\underline{11.18 \angle -26.56}}$$

$$\frac{R_{Th}}{Z_{Th}} = 7.07 \angle -8.13 = 6.998 - j0.999$$

$$\approx 7 - j \Omega$$

equivalent ct



$$i_{Th} = \frac{3.605 \angle -19.44}{7 - j + 10 + j5}$$

$$= \frac{3.605 \angle -19.44}{17 + j4}$$

$$i_{Th} = 0.206 \angle -32.68 \text{ Peak} \approx 145.6 \text{ mA rms}$$

$$V_{R2} = i_{Th} * R_2 = 1.456 \text{ V rms} = 0.206 \angle -32.68 * 10$$

$$= 2.06 \angle -32.68 \text{ V peak}$$

using Norton.

[3]

$$\underline{Z_{Th} = Z_N = 7 - j = 7.07 \angle -8.13}$$

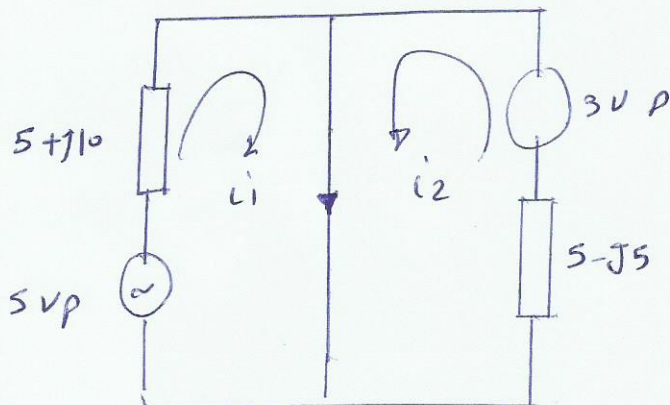
$$I_N = I_{sc}$$

$$I_{sc} = I_1 + I_2$$

$$= \frac{5}{5 + j10} + \frac{3}{5 - j5}$$

$$= \frac{5}{11.18 \angle 63.43} + \frac{3}{7.07 \angle -45}$$

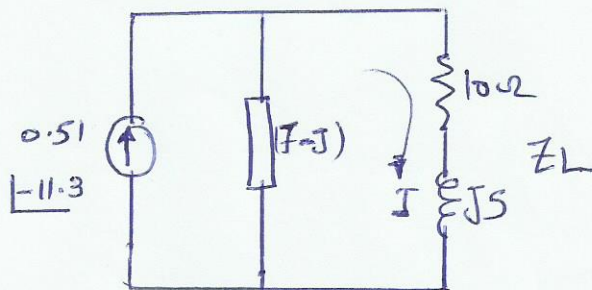
$$= 0.5 - j0.1 = \underline{0.51 \angle -11.3} \text{ A peak}$$



equivalent ct

$$I = 0.51 \angle -11.3 \frac{7.07 \angle -8.13}{(10 + j5) + (7 - j)}$$

$$= 0.2064 \angle -32.67 \text{ A peak}$$



$$I_{rms} = 145 \text{ mA rms}$$

$$V_{R2} = 1.45 \text{ V rms.}$$

Task 1: B

$$X_{c2} = -j10 \rightarrow C = \frac{1}{2\pi f \times 10} = 15.923 \mu F$$

$$X_{L2} = j5 \rightarrow L_2 = 0.796 \text{ mH}$$

$$X_{L1} = j16 \rightarrow L_1 = 1.5923 \text{ mH}$$

$$X_{L3} = j5 \rightarrow L_3 = 0.796 \text{ mH}$$

to be used in Multisim to verify the answer.

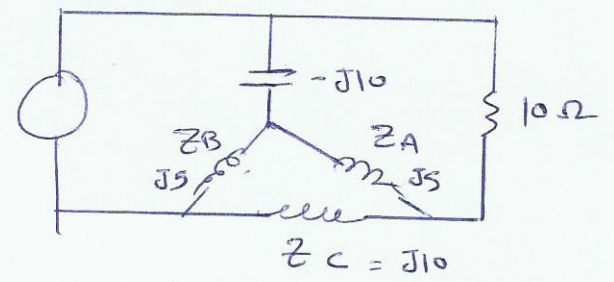
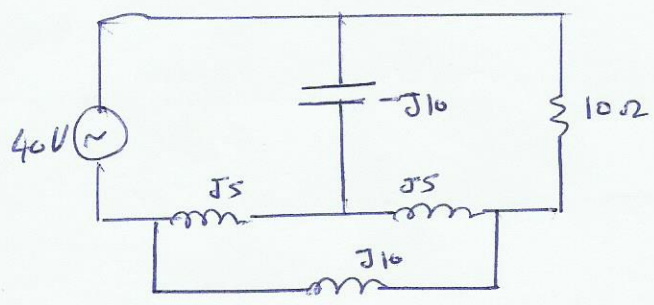
Simulation

$$I_{total} = 4.65 \text{ Arms.}$$

$$Z_{total} = \frac{V_s}{I_t} = \frac{40 \angle 0}{6.57 \angle -60} = 6.08 \angle 60 \text{ } \checkmark$$

$Z_t$ : magnitude.

using Delta-Star.

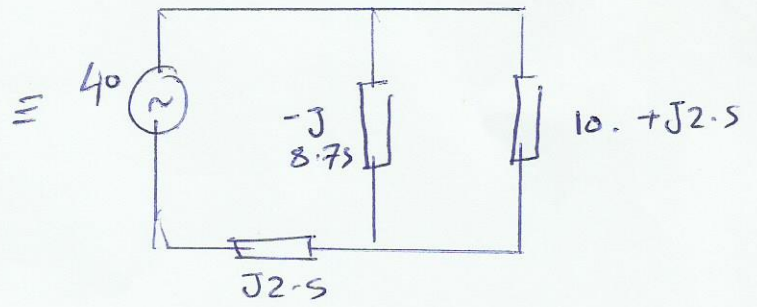
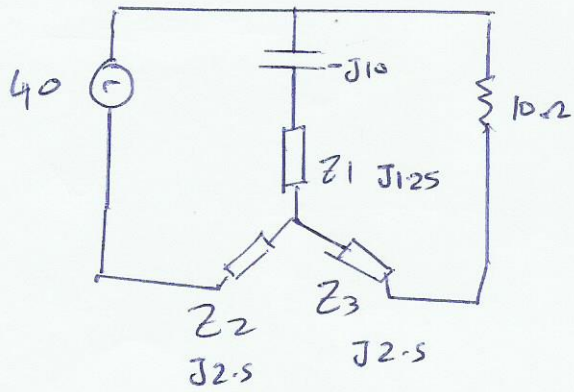


$$Z_1 = \frac{Z_A Z_B}{Z_A + Z_B + Z_C} = \frac{(j5)(j5)}{j5 + j5 + j10} = \boxed{j1.25}$$

$$Z_2 = \frac{Z_B Z_C}{Z_A + Z_B + Z_C} = \frac{(j5)(j10)}{j20} = \boxed{j2.5}$$

$$Z_3 = \frac{Z_C Z_A}{Z_A + Z_B + Z_C} = \frac{(j10)(j5)}{j20} = \boxed{j2.5}$$

- $Z_A = j5$
- $Z_B = j5$
- $Z_C = j10$

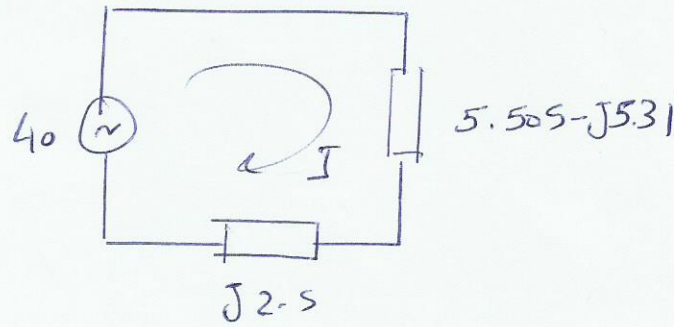


$$Z_{11} = (-j8.75) \parallel (10 + j2.5) = \frac{(10 + j2.5)(-j8.75)}{(10 + j2.5) - j8.75}$$

$$= 7.6 \angle -43.97^\circ = 5.505 - j5.31 \Omega$$

$$\therefore I = \frac{40}{5.505 - j5.31 + j2.5}$$

$$= 6.47 \angle 27.04^\circ \text{ A}_{\text{peak}}$$



$$Z_T = 6.18 \angle -27.04^\circ \Omega$$

Sim  $\omega = 100$

Task 2.

$$C \rightarrow -j50 = \frac{1}{j2\pi fC} \quad \therefore C = \underline{3.185 \mu F}$$

From Simulation.

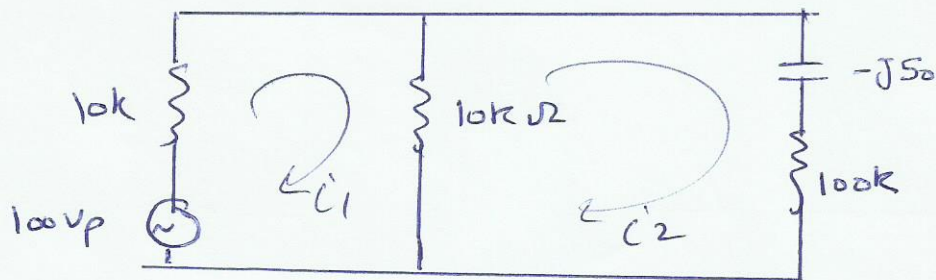
$$I_{(C_1, R_3)} = 335.504 \text{ mA}_{\text{rms}}$$

$$V_{R_3} = 33.664 \text{ V}_{\text{rms}}$$

$$\therefore P = \underline{11.294 \text{ mW}}$$

using Mesh.

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Loop(1)

$$100 = i_1(20k) - i_2(10k) \rightarrow (1)$$

$$0 = -i_1(10k) + i_2(110k - j50) \rightarrow (2)$$

Solving 1, 2

$$I_2 = 476.2 \mu A \angle 0.027^\circ \text{ p A} = \underline{336.7 \mu A \text{ rms}}$$

$$I_1 = 5 \times 10^{-3} + 0.5 I_2$$

$$I_1 = \underline{5.168 \text{ mA rms}}$$

∴ Power of R3

$$= I_{\text{rms}}^2 R$$

$$= \underline{11.33 \text{ mWatt}}$$

V<sub>C1</sub>

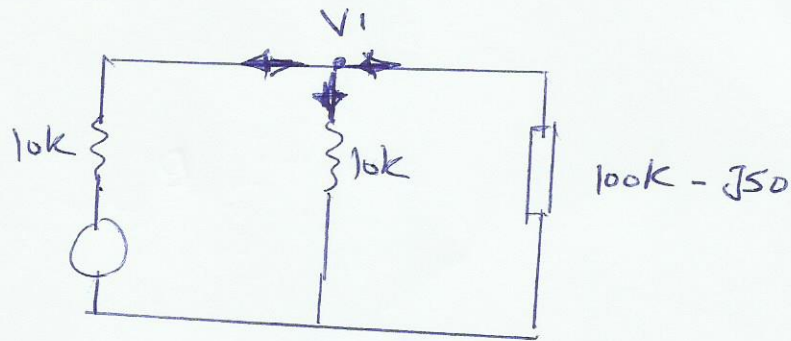
$$= i_2 * (-j50)$$

$$= 476.2 \times 10^{-6} \angle 0.027^\circ (50 \angle -90^\circ)$$

$$= \underline{23.81 \text{ m} \angle -89.97^\circ \text{ peak}}$$

## Task 2 - using Nodal

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$$\frac{V_1}{10k} + \frac{V_1}{100k - j50} + \frac{V_1 - 100}{10k} = 0$$

Solving for  $V_1$

$$\begin{aligned} 100 &= V_1 (2 + 0.1 \underline{10.028}) \\ &= V_1 (2 + 0.1 + \underline{1.0028} \times 10^{-5}) \\ &\quad \rightarrow \text{neglected} \end{aligned}$$

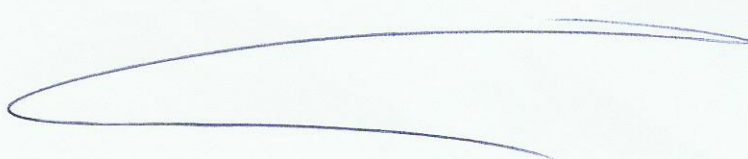
$$100 \approx V_1 (2.1)$$

$$\therefore V_1 = 47.619 \text{ V peak}$$

$$\underline{I} = \frac{V_1}{100k} = 476.2 \text{ } \mu\text{A peak}$$

$$= 336. \text{ } \mu\text{A}_{\text{rms}}$$

∴ The same as Mesh



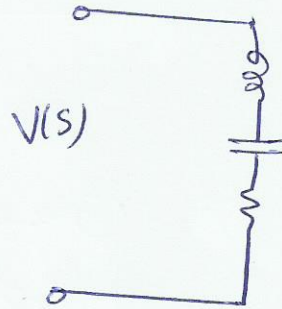
D. M. M.

### Task (3)

$$F_r = 10k = 10 \times 10^3 = \frac{1}{2\pi \sqrt{LC}}$$

$$\therefore L = 15 \times 10^{-3}$$

$$\therefore C = 16.9 \text{ nF}$$



From multiSim.

$$I = 70.688 \text{ mA rms}$$

$$V_{\text{rms}} = \frac{100}{\sqrt{2}} = 70.7 \text{ V rms.}$$

$$Z_{\text{res}} = \frac{70.7}{70.688} \approx 1k\Omega \Rightarrow R_{\text{only}} \checkmark$$

at  $\frac{F_r}{2}$

$$Z_t = |Z_t| \angle \theta_{Z_t}$$

$$\text{From Sim } |Z_t| = 1.705 k\Omega$$

(1)  $C = 16.9 \text{ nF}$

(2)  $Z_t = R + j(X_L - X_C) = R = 1k$  at Resonance

(3)  $Z_t$  at  $\frac{F_r}{2}$

$$X_L = j2\pi FL = 2\pi \times 5 \times 10^3 \times 15 \times 10^{-3} = j471 \Omega$$

$$X_C = \frac{1}{j\omega C} = -j1.884 k\Omega$$



$$Z_t = 1000 + j(471 - 1884)$$

$$= 1000 - j1413 = 1.73k \angle -54.7^\circ$$

$$(4) \phi_r = \frac{\omega L}{R} = 0.942$$

$$(5) Bw = \frac{F_r}{\phi_r} = \frac{10 \times 10^3}{0.942} = 10615 \text{ Hz}$$

(6) not selective since  $Bw > 20\% F_r$

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~~D. M. A.~~