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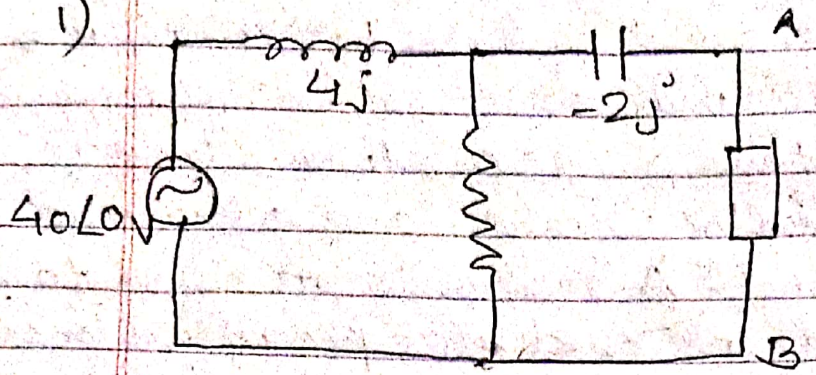
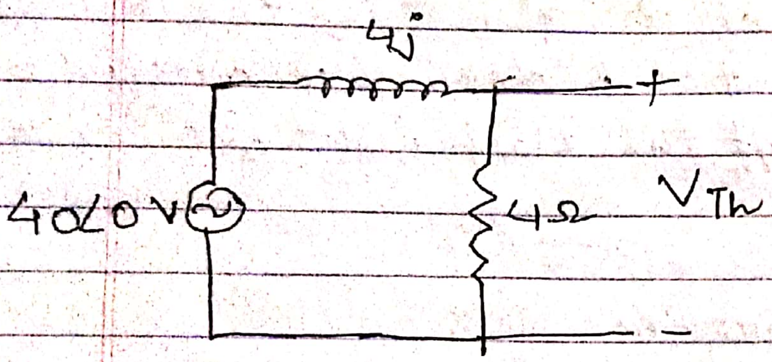
# Electrical Science - 1

## Assignment - 2

1)




$$P_{max} = \frac{|V_{max}|^2}{8 R_{Th}}$$




$$i = 40/(4+4j)$$

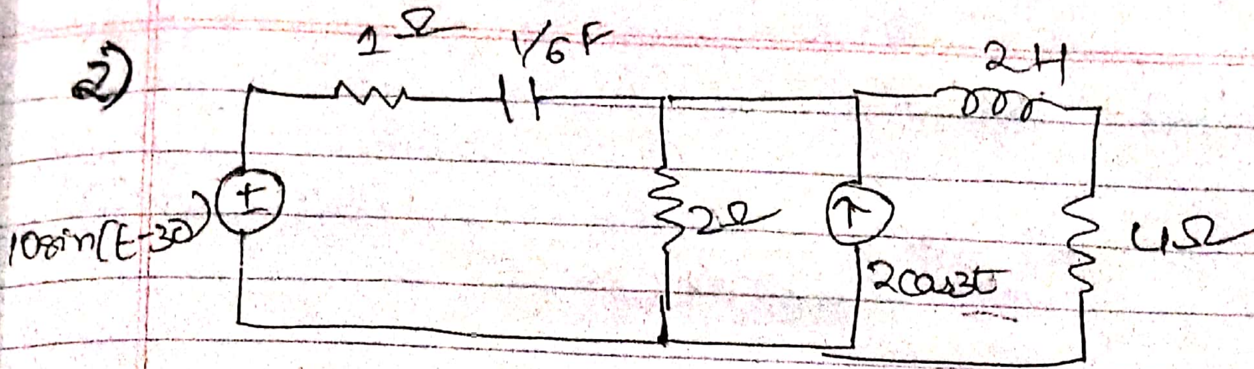
$$V_{th} = 4\left(\frac{40}{4+4j}\right) = 40/(1+j)$$

$$= \frac{40(1-j)}{2} = 20-20j = 20\sqrt{2}\angle 185$$

$$Z_{th} = \frac{16j}{4+4j} + (-2j) = \frac{16j - 8j + 8}{4+4j} = 2$$

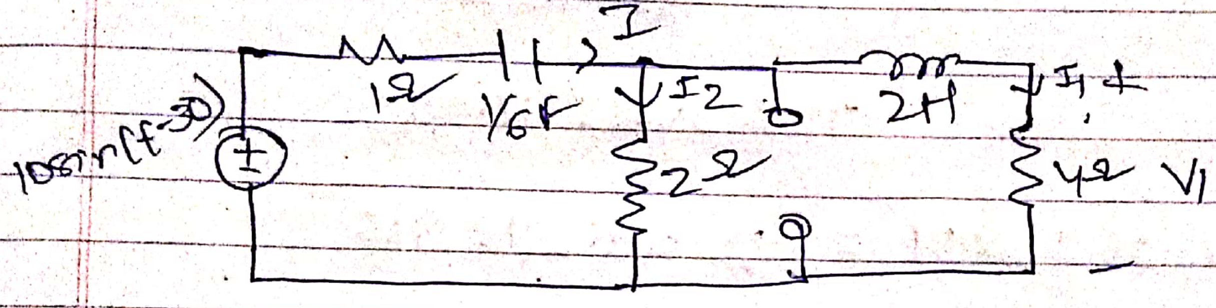
$$P_{max} = \frac{(20\sqrt{2})^2}{8 \times 2} = 100\,W \quad \left[P_{max} = 100W\right]$$

2)




Applying superposition theorem

When 10sin(t-30) voltage source is active




$$R = (1-j6) + \frac{2(4+j2)}{2+4+j2}$$

$$R = 1 - j6 + \frac{8+j4}{6+j2}$$

$$R = 1 - j6 + \frac{4+j2}{3+j}$$

$$R = \frac{3 - j18 + j + 6 + 4 + j2}{3+j}$$

$$R = \frac{13-j15}{3+j} = \frac{\sqrt{(13)^2+(15)^2}}{\sqrt{(3)^2+1}} \angle \left(\tan^{-1}\frac{15}{13} - \tan^{-1}\left(\frac{1}{3}\right)\right)$$

$$= \frac{19.849}{3.162} \angle (49.085 - 18.435)$$

$$R = 6.277 \angle 30.65$$

$V(\omega) = 10\angle 60$

$\therefore I = \frac{V(\omega)}{R} = \frac{10\angle 60}{6.277\angle 30.65} = 1.593\angle 29.35$

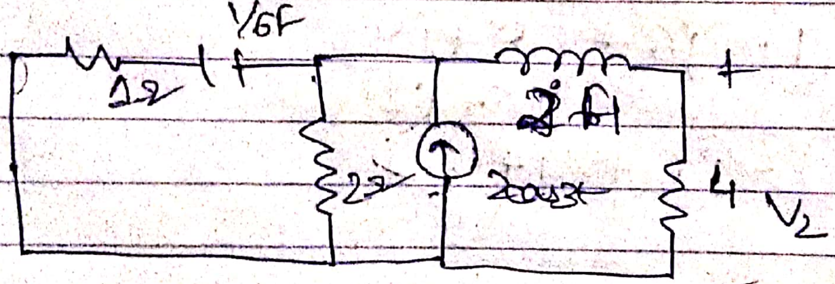
there $I_1 = \frac{I \times 2}{2+(4+j2)} = \frac{1.593\angle 29.35 \times 2}{6+j2}$

$= \frac{1.593\angle 29.35 - 18.435}{3.162}$

$= 0.504\angle 10.915$

$V_1 = I_1 \times 4 = 2.016\angle 10.915$

Now when 2cos3t current source is active

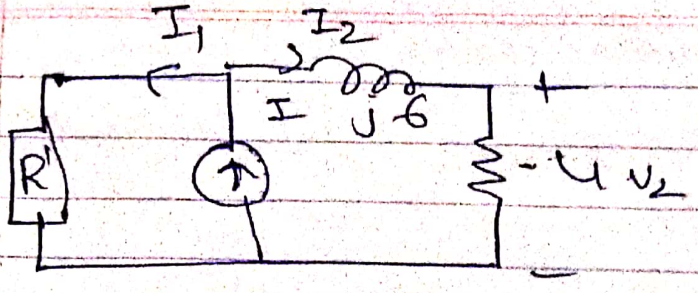



$R_C = \frac{-j}{\omega C} = -j2$, $R_L = j\omega L = j6$

Now

$R' = \frac{(1-j2)\times 2}{3-2j} = \frac{2-j4}{13}(3+2j)$

$= \frac{6+4j-12j+8}{13} = \frac{14-8j}{13}$




Here $I_2 = \dfrac{I \times R'}{R' + (4+6j)} = \dfrac{2\angle 0 \times \frac{2}{13}(7-4j)}{\frac{2}{13}(7-4j) + 2(2+3j)}$

$I_2 = \dfrac{\frac{11}{13}(8.062)\angle -29.745}{\frac{2}{13}(7-4j + 26+39j)}$

Hence $I_2 = 0.335\angle -32.423$

$\therefore V_2 = I_2 \times 4$
$= 1.34\angle -32.423$

$\therefore V_{4\Omega} = V_1 + V_2 = 2.016\angle 10.915 + 1.34\angle -32.4$

$V_{4\Omega} = 2.016\cos(t + 10.915) + 1.34\cos(3t - 32.423)$

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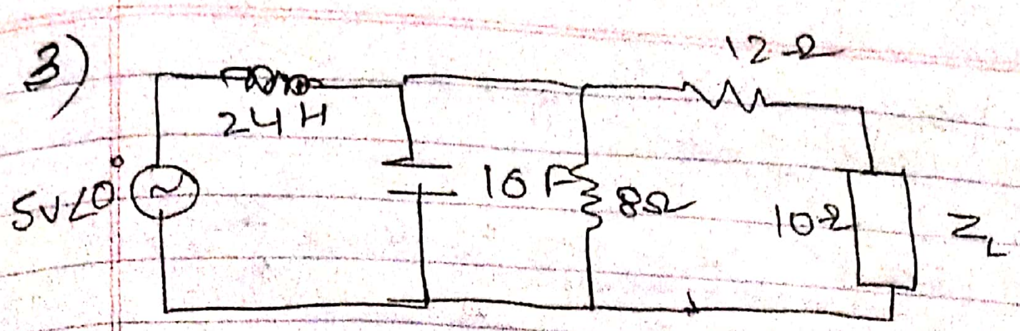
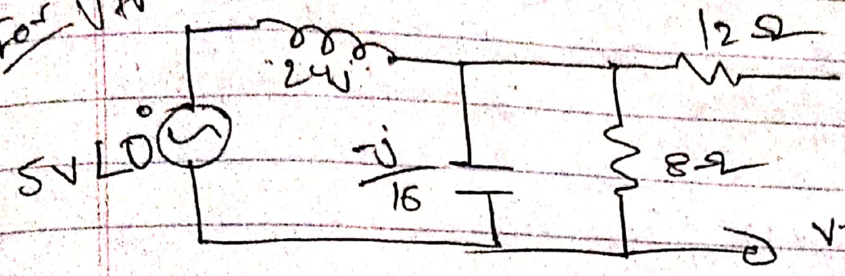
3)




For $V_{th}$




∵ 16F & 8Ω in ||

$V_{th}$ $\left(\frac{-j}{16}+\frac{1}{8}\right)^{-1} = \frac{16j}{1+2j}$

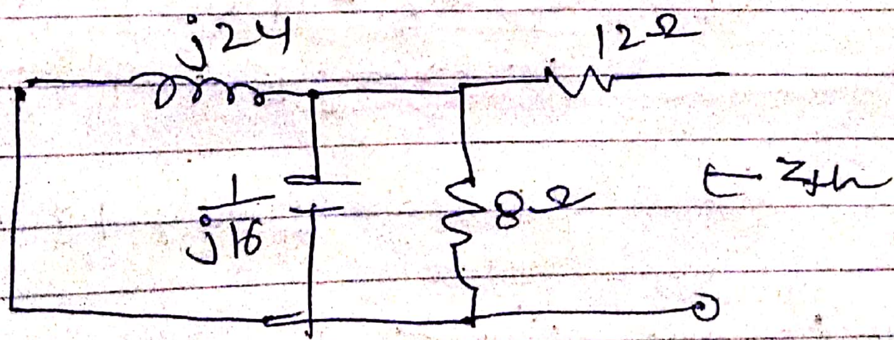
$= [6.4 + j3.2]$

$$V_{th} = \frac{5\times(6.4 + j3.2)}{j24 + (6.4 + j3.2)}$$

$$= \frac{32 + 16j}{6.4 + j27.2} = \frac{35.77 \angle 2.70 - 13.73}{27.94}$$

$$V_{th} = 1.28 \angle -11.03$$

Now $Z_{th}$




$$Z_{th} = j24 \,||\, (6.4 + 3.2j) + 12$$

$$= \frac{24j(6.4 + 3.2j)}{j24 + 6.4 + j3.2} + 12$$

$$Z_{th} = \frac{153.6j - 76.8}{6.4 + j27.2} + 12$$

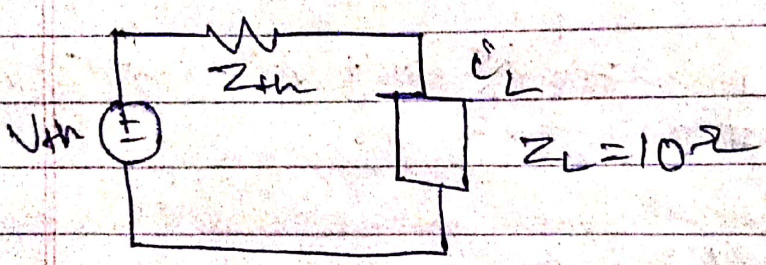
$$= \frac{153.6j - 76.8 + 76.8 + j326.4}{6.4 + j27.2}$$

$$= \frac{480j}{6.4 + j27.2} = \frac{480\angle 90}{27.94\angle 13.73}$$

$$Z_{th} = 17.18\angle 76.27$$

$$Z_{th} = 4.078 + j16.689$$

Equivalent circuit




$$i_L = \frac{V_{th}}{Z_{th} + Z_L}$$

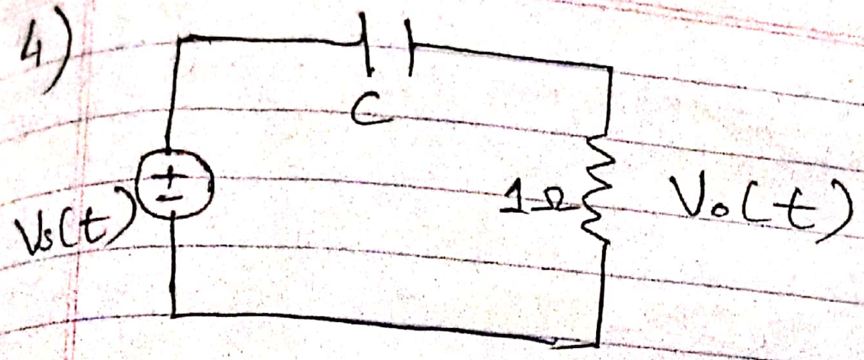
$$i_L = \frac{1.28\angle -11.03}{14.078 + j16.689} = \frac{1.28\angle -11.03}{21.83\angle 6.149}$$

$$i_L = 0.058\angle -17.179$$

$$P_{max} = i_L^2 \cdot Z_L$$
$$= (0.058)^2 \cdot 10$$

$$\left[ P_{max} = 0.0337 \text{ watt} \right)$$

4)




$$V_s(t) = 7.68\cos(2t + 47^\circ)$$
$$V_o(t) = 1.59\cos(2t + 125^\circ)$$

$$i_o(t) = 1.59\cos(2t + 125^\circ)$$

$$i_o(t) = 1.59\angle 125^\circ \text{ A}$$

$$X_c = \frac{-j^\circ}{2 \times C} = \frac{-0.5j^\circ}{C}$$

$$V_s(t) = I_o(t) \times Z$$

$$\frac{7.68\angle 47^\circ}{1.59\angle 125^\circ} = 1 - j\frac{0.5}{C}$$

$$4.83\angle -78^\circ = 1 - j\frac{0.5}{C}$$

$$4.83\angle -78^\circ = \sqrt{1 + \frac{0.25}{C^2}} \tan^{-1}\left(\frac{-j0.5}{C}\right)$$

On comparison

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$$4.83 = \sqrt{1 + \frac{0.25}{c^2}}$$

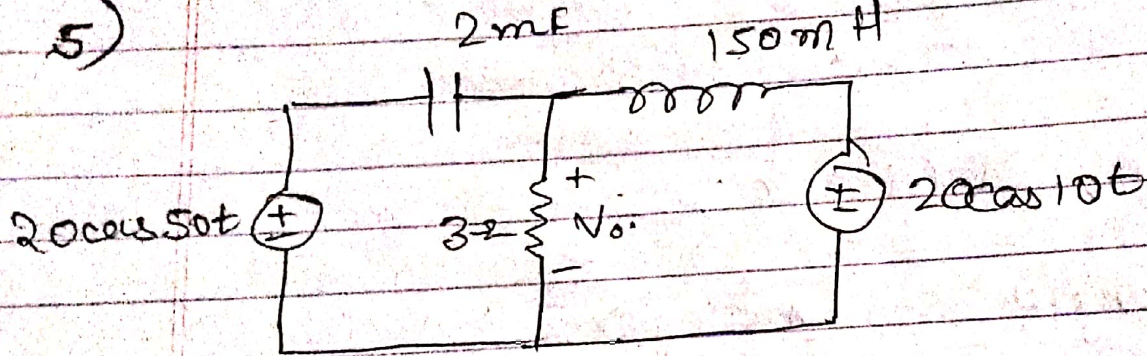
$$23.32 = 1 + \frac{0.25}{c}$$

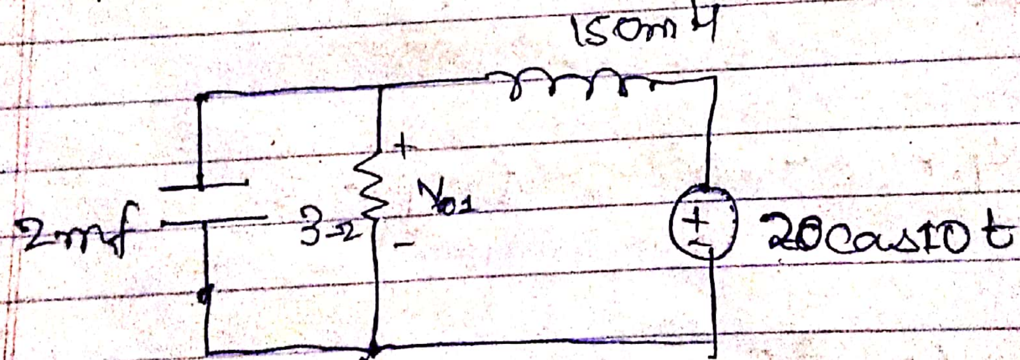
$$22.32c^2 = 0.25$$

$$c^2 = \frac{0.25}{22.32}$$

$$C = \sqrt{\frac{0.25}{22.32}} = \sqrt{0.011} = 0.1058F$$

5)




$$X_c = \frac{-j}{10 \times 2 \times 10} = -j\,50$$

$$Z_{net} = \frac{-j400}{8-j50} + j1.5 = \frac{-j400 + 12j + 75}{8-j50}$$

$$= \frac{75 - j388}{8 - j50} = \frac{395.18 \angle -1.198 + 11.106}{50.63}$$

$$Z_{net} = 7.80 \angle 9.908\ \Omega$$

Now, $V_{150mH} = \frac{V \times 1.5\angle 90}{Z_{net}} = \frac{20\angle 0 \times \angle 1.5\angle 90}{7.80\angle 9.908}$

$$= \frac{30}{7.80} \angle 90 - 9.908$$

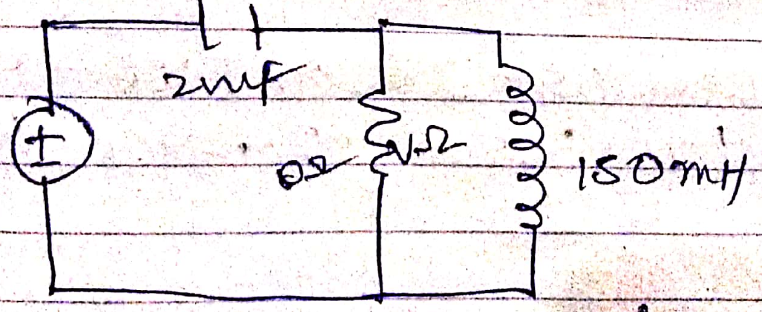
$$= 3.846 \angle 80.092$$

$$V_{01} = V - V_{150mH}$$

$$V_{01} = 20\angle 0 - 3.846\angle 80.092.$$

$$V_{01} = 2\cos 10t - 3.846\cos(10t + 80.4)$$

When $20\cos 5t$ voltage source is active




$Z_C = -j10$

$Z_L = j7.5$

$$Z_{net} = \frac{j7.5 \times 8}{8 + j7.5} - j10$$

$$Z_{net} = \frac{60j - j80 + 75}{8 + j7.5} = \frac{75 - 20j}{8 + 7.5j}$$

$$Z_{net} = \frac{77.62}{10.97} \angle -1.16 - 11.05$$

$$[Z_{net} = 7.08 \angle -12.21]$$

Now. $V_{2mf} = \frac{V}{Z_{net}} \times -j10$

$$= \frac{20\angle 0}{7.080\angle -12.21} \times 10\angle -90$$

$$= \frac{200}{7.08} \angle -90 + 12.21$$

$$= 28.24 \angle -77.79$$

$$V_{o2} = V - V_{2mf}$$

$$= 20\angle 0 - 28.24\angle -77.79$$

$$= 20\cos 50t - 28.24\cos(50t - 77.79)$$

$$V_o = V_{o1} + V_{o2}$$

$$V_o = (20\cos 10t - 3.85\cos(10t + 80.09))$$
$$+ (20\cos 50t - 28.24\cos(50t - 77.79))$$

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