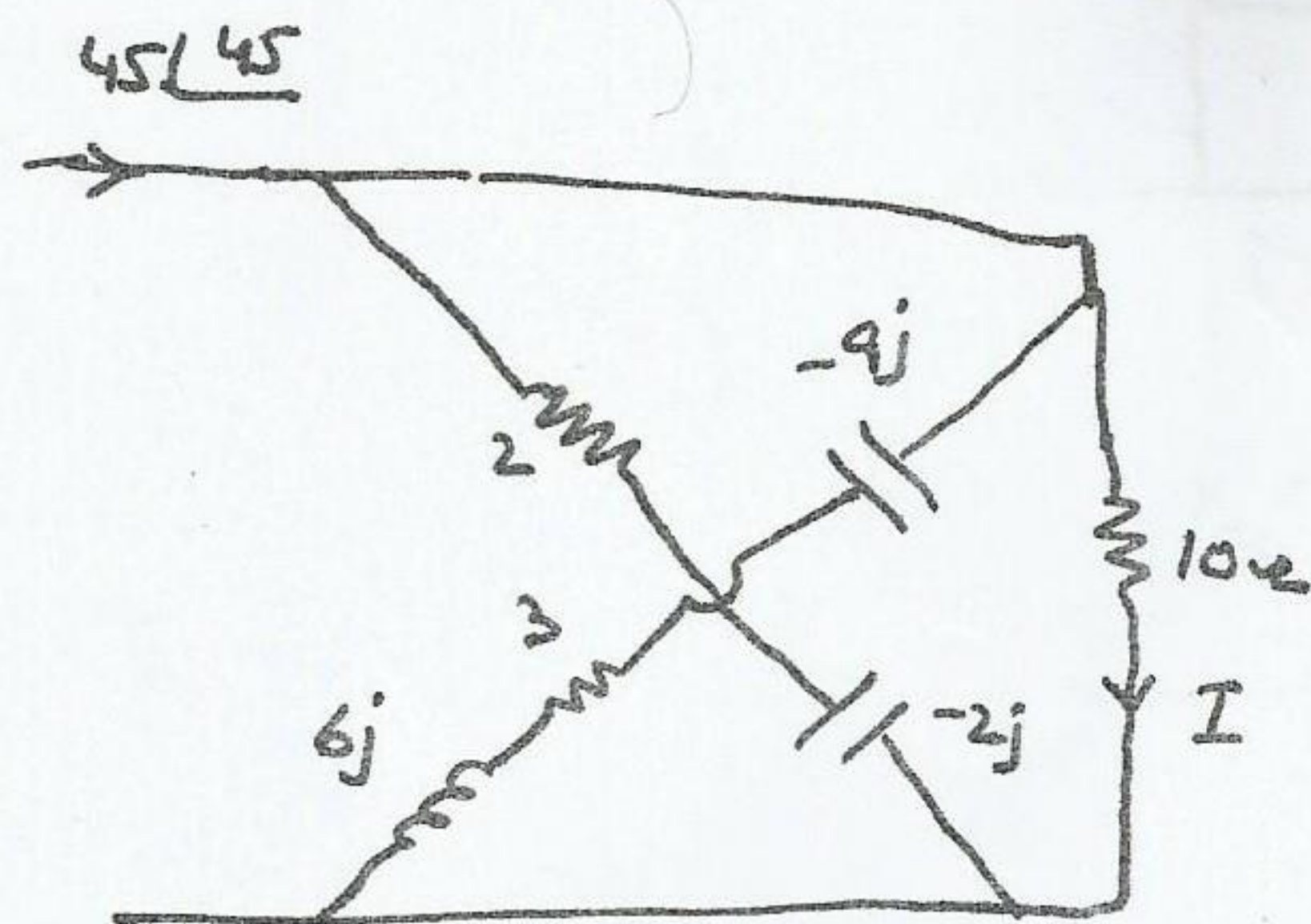
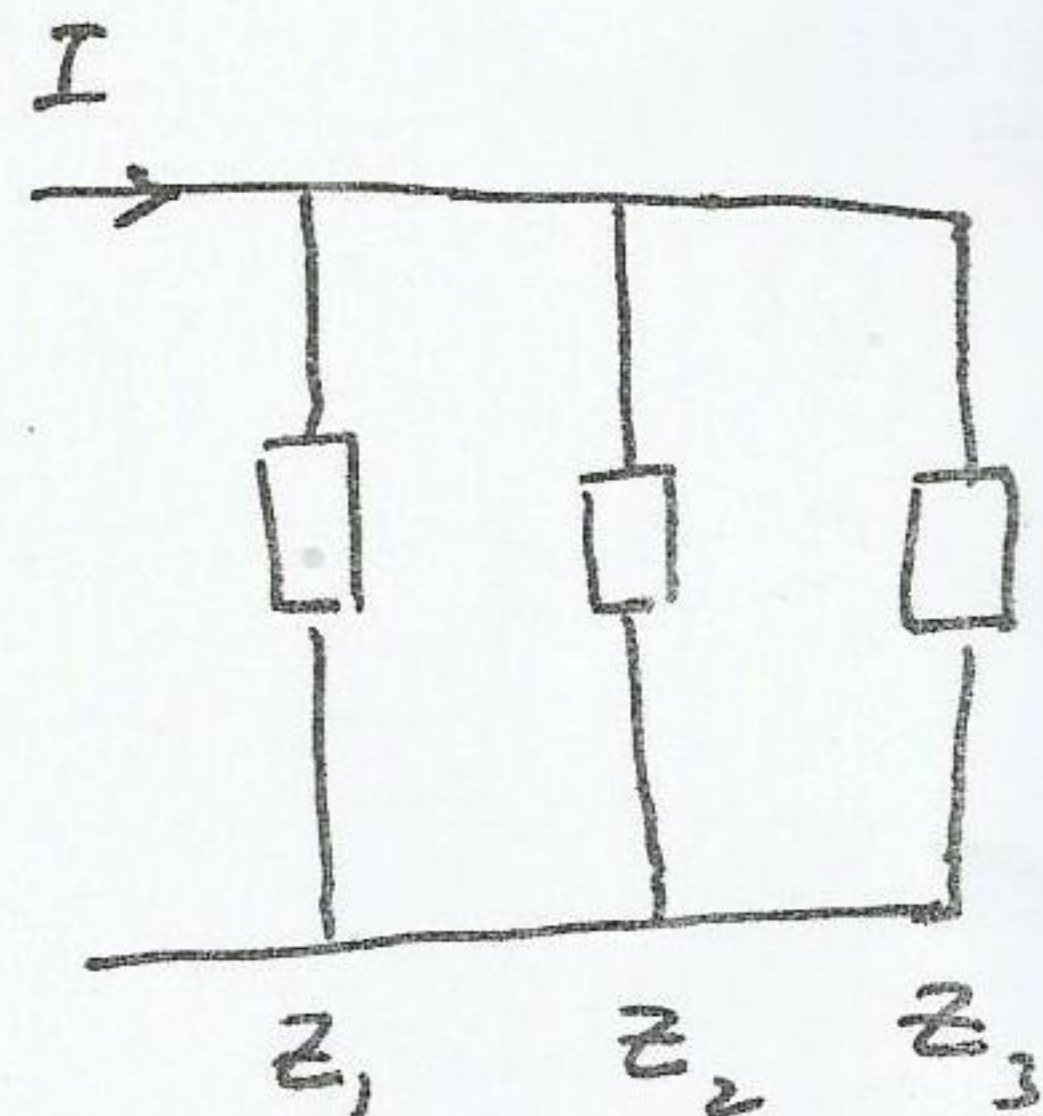


②



⇒



$$Z_1 = 2 - 2j$$

$$= 2.828 \angle -45^\circ$$

$$Z_2 = 3 + 6j - 9j$$

$$= 3 - 3j$$

$$= 4.24 \angle -45^\circ$$

$$Z_3 = 10\Omega$$

$$= 10 \angle 0^\circ$$

$$Y_T = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} = \frac{1}{2.82 \angle -45^\circ} + \frac{1}{4.24 \angle -45^\circ} + \frac{1}{10}$$

$$= 0.354 \angle 45^\circ + 0.236 \angle 45^\circ + 0.1 = 0.59 \angle 45^\circ + 0.1$$

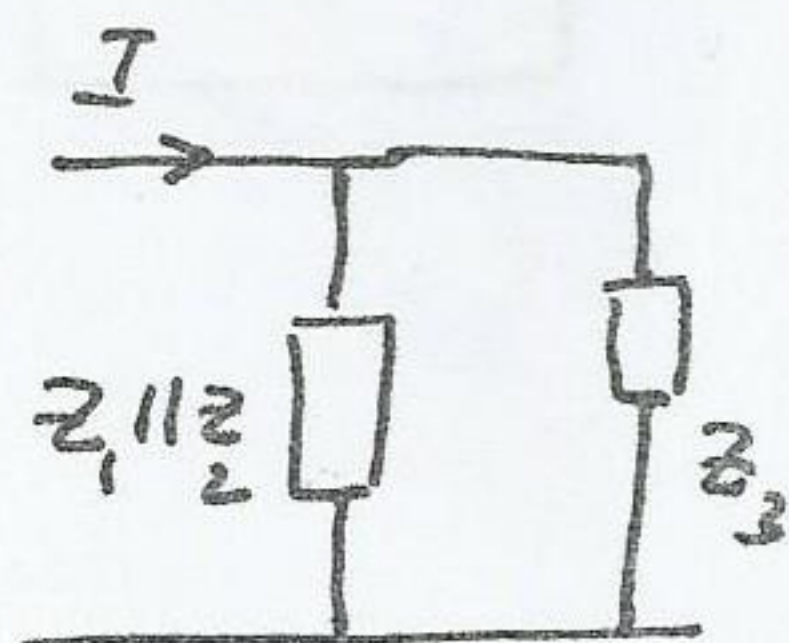
$$= 0.417 + j0.417 + 0.1 = 0.517 + 0.417j$$

$$= 0.664 \angle 38.889^\circ$$

$$Z_T = \frac{1}{Y_T} = \frac{1}{0.664 \angle 38.889^\circ} = 1.506 \angle -38.889^\circ$$

$$V = I Z_T = (45 \angle 45^\circ) (1.506 \angle -38.889^\circ)$$

$$= 67.77 \angle 6.11^\circ$$



$$I_{Z_3(10\Omega)} = ?$$

$$Z_1 \parallel Z_2 = \frac{(3 - 3j)(2 - 2j)}{3 - 3j + 2 - 2j} = \frac{6 + 6j^2 - 6j - 6j}{5 - 5j} = \frac{-12j}{5 - 5j}$$

$$= \frac{12 \angle -90^\circ}{7.07 \angle -45^\circ} = 1.697 \angle -45^\circ$$

$$I_{10\Omega} = \frac{(45 \angle 45^\circ) (1.697 \angle -45^\circ)}{10 + 1.697 \angle -45^\circ} = \frac{76.367}{10 + 1.2 - 1.2j}$$

$$= \frac{76.365}{11.2 - j1.2} = 6.78 \angle 6.11^\circ \text{ amp.}$$

[6 marks]



Q.3 [8 marks]

$$X_{C1} = \frac{1}{377(663 \times 10^{-6})} = -4j \quad \frac{50}{\sqrt{2}} \angle 0^\circ$$

$$X_{C2} = \frac{1}{377(884 \times 10^{-6})} = -3j$$

$$X_L = 377(10.61 \times 10^{-3}) = 4j$$

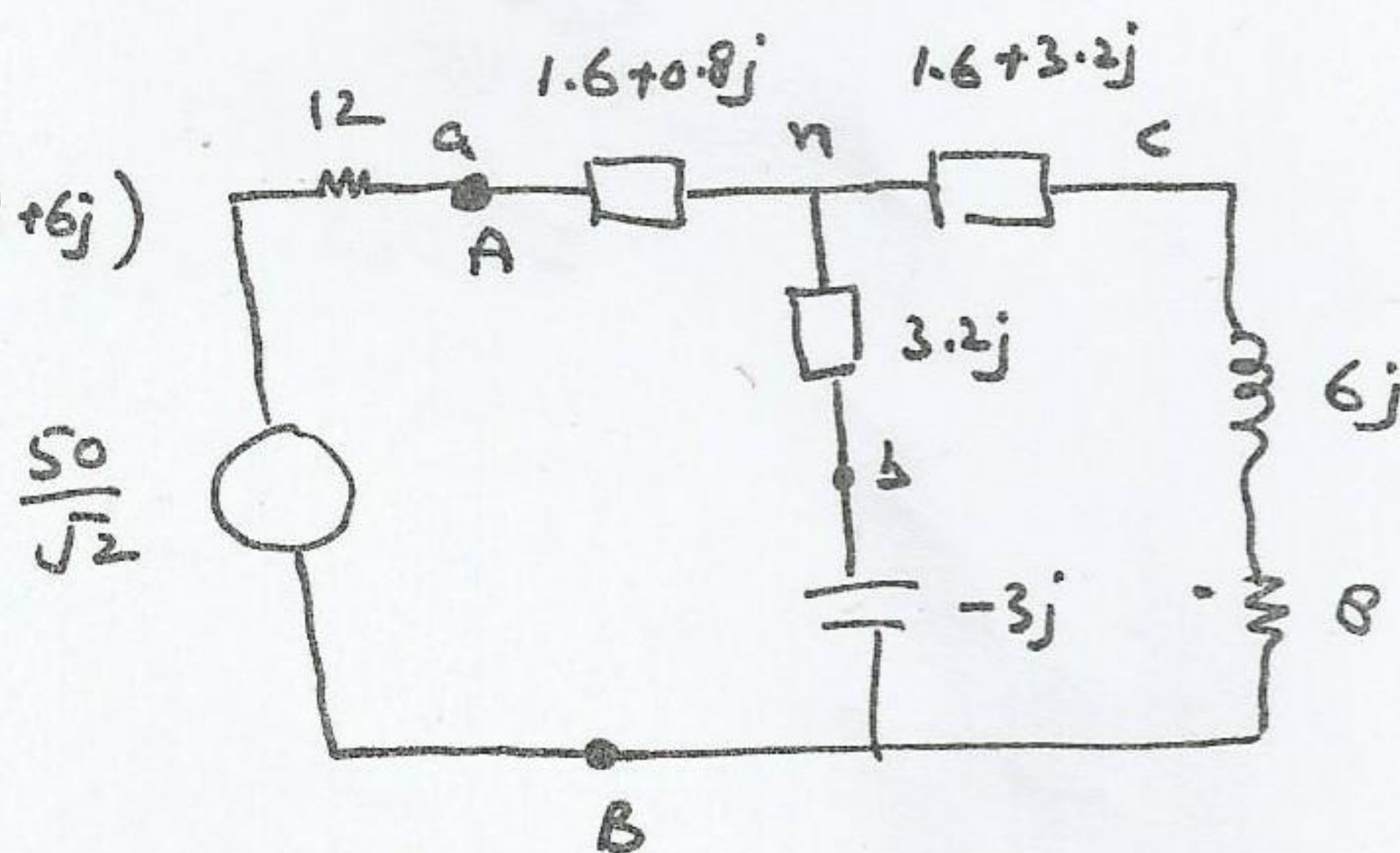
$$X_{L2} = 6j$$

$$Z_{an} = \frac{4j(2-4j)}{4j+2-4j+8} = 1.6 + 0.8j$$

$$Z_{bn} = \frac{8(4j)}{10} = 3.2j$$

$$Z_{cn} = \frac{8(2-4j)}{10} = 1.6 - 3.2j$$

a)  $Z_{AB} = Z_{an} + (Z_{bn} - 3j) \parallel (Z_{cn} + 8 + 6j)$   
 $= 1.6 + j1 = 1.8 \angle 32^\circ$



b)  $Z_{total} = Z_{an} + 12$   
 $= 13.6 + j1 = 13.64 \angle 4.206^\circ$

$$I = \frac{V}{Z} = \frac{50/\sqrt{2}}{13.64 \angle 4.206^\circ} = \frac{3.66}{\sqrt{2}} \angle -4.204^\circ = 2.6 \angle -4.204^\circ$$

c)  $\frac{V_n - 50/\sqrt{2}}{13.6 + j0.8} + \frac{V_n}{0.2j} + \frac{V_n}{9.6 + 2.8j} = 0$

$$(V_n - 35.35)(0.2j)(9.6 + 2.8j) + V_n(13.6 + 0.8j)(9.6 + 2.8j) +$$

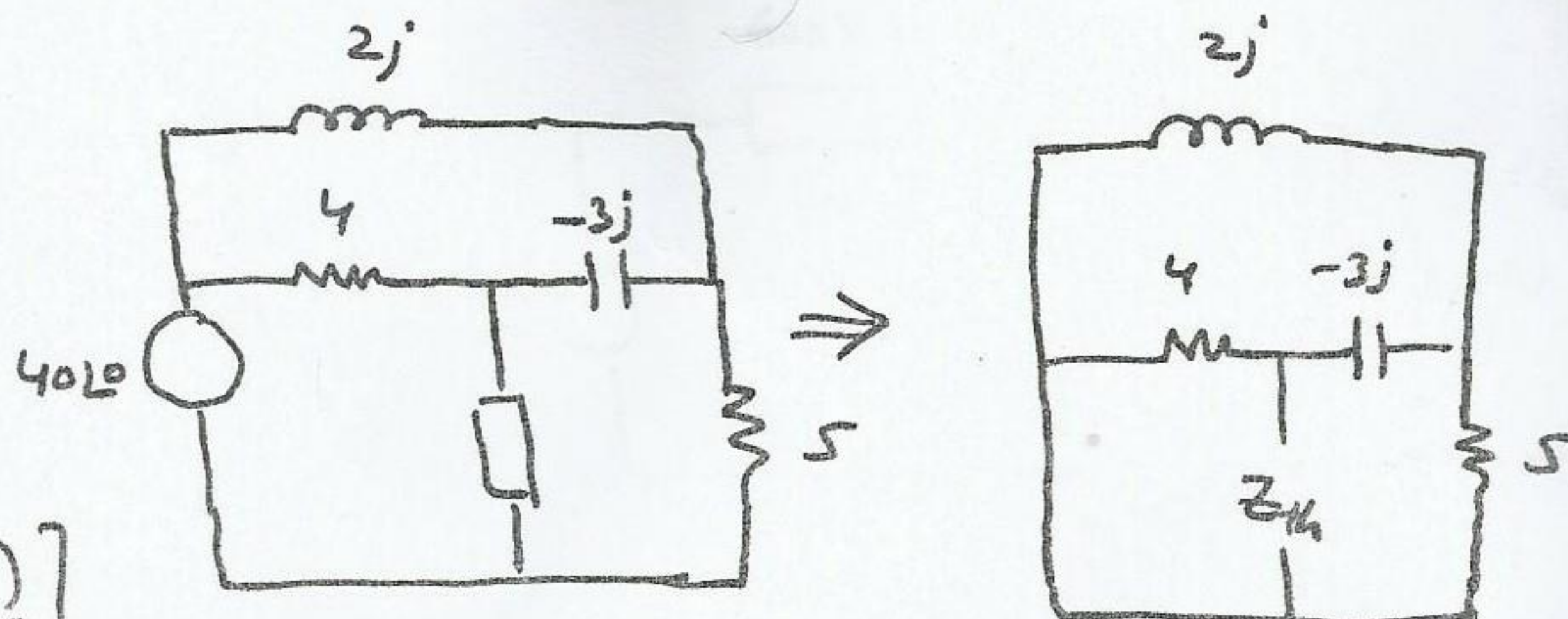
$$V_n = 0.048 + 0.513j = 0.515 \angle 84.7^\circ + V_n(0.2j)(13.6 + j0.8) = 0$$

then  $V_b = \frac{V_n}{0.2j}(-3j) = -0.713 - 7.7j = 529.673 \angle 179.17^\circ$   
 $= 7.78 \angle -95.3^\circ$



④

[7 marks]



$$(a) \quad Z_{th} = \frac{4 \left[ -3j + \left( \frac{5 \times 2j}{5+2j} \right) \right]}{4 - 3j + \frac{5 \times 2j}{5+2j}} = \frac{4 [0.6896 - j1.2758]}{4.69 - j1.2758}$$

$$= \frac{4 (1.45 \angle -361.761)}{4.86 \angle -15.22} = 1.19 \angle -46.39^\circ$$

$$Z_{th} = 0.822 - j0.8642$$

$$(b) \quad Z_L (\text{max power}) = Z_{th}^* = 0.822 + j0.8642$$

$$(c) \quad P_{max} = \frac{V_{th}^2}{4R} \quad \text{where } V_{th} = 40 - 4I$$

$$\quad \quad \quad \text{where } I = \frac{40 - V_2}{4 - 3j}$$

$$\text{where } V_2 = ?$$

$$\frac{V_2 - 40}{4 - 3j} + \frac{V_2 - 40}{2j} + \frac{V_2}{5} = 0$$

$$V_2 = 31.5 \angle -20.62 = 29.48 - j11.09$$

$$I = \frac{40 - V_2}{4 - 3j} = \frac{40 - 29.48 + j11.09}{4 - 3j} = 3.058 \angle 83.39^\circ$$

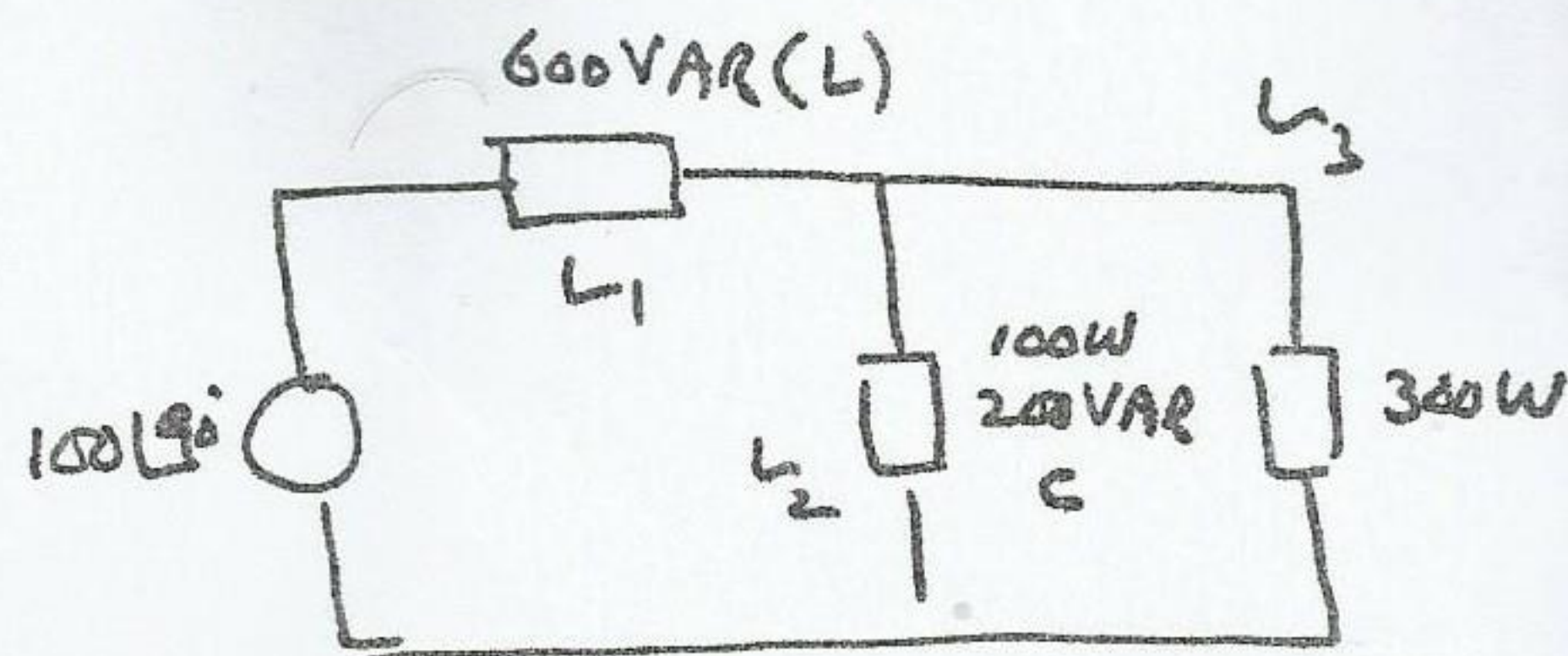
$$= 0.352 + j3.038$$

$$V_{th} = 40 - 4I = 38.59 - j12.152 = 40.46 \angle -17.48^\circ$$

$$P_{max} = \frac{V_{th}^2}{4R} = \frac{40.46^2}{4(0.823)} = \frac{1637.4}{3.292} = 497.4 \text{ W}$$



Q.5 [ 6 marks ]



$$L_1 \Rightarrow P_1 = 0 \\ Q_1 = 600 \text{ VAR (L)}$$

$$L_2 \Rightarrow P_2 = 100 \text{ W} \\ Q_2 = -200 \text{ VAR (C)}$$

$$L_3 \Rightarrow P_3 = 300 \text{ W} \\ Q_3 = 0$$

$$(a) \quad P_T = P_1 + P_2 + P_3 = 0 + 100 + 300 = 400 \text{ W}$$

$$Q_T = Q_1 + Q_2 + Q_3 = 600 - 200 + 0 = 400 \text{ VAR}$$

$$S_T = \sqrt{P_T^2 + Q_T^2} = \sqrt{400^2 + 400^2} = 565.68 \text{ VA}$$

$$(b) \quad \underline{I} = \frac{\underline{S}}{\underline{V}} = \frac{565.68 \angle 45^\circ}{100 \angle 90^\circ} = 5.65 \angle -45^\circ$$

$$(c) \quad \text{P.f.} = \frac{P_T}{S_T} = \frac{400}{565} = 0.707 \text{ (lag)}$$

$$(d) \quad \theta = 0^\circ \quad \cos \theta = 1$$

$$Q'_C = P_T \tan \theta = 0$$

$$\therefore Q_L - Q'_L = 400 - 0 = 400$$

~~Q\_L - Q'\_L = 400 - 0 = 400~~

$$Q_C = \frac{E^2}{X_C} = \frac{100^2}{400} = 25 \Omega$$