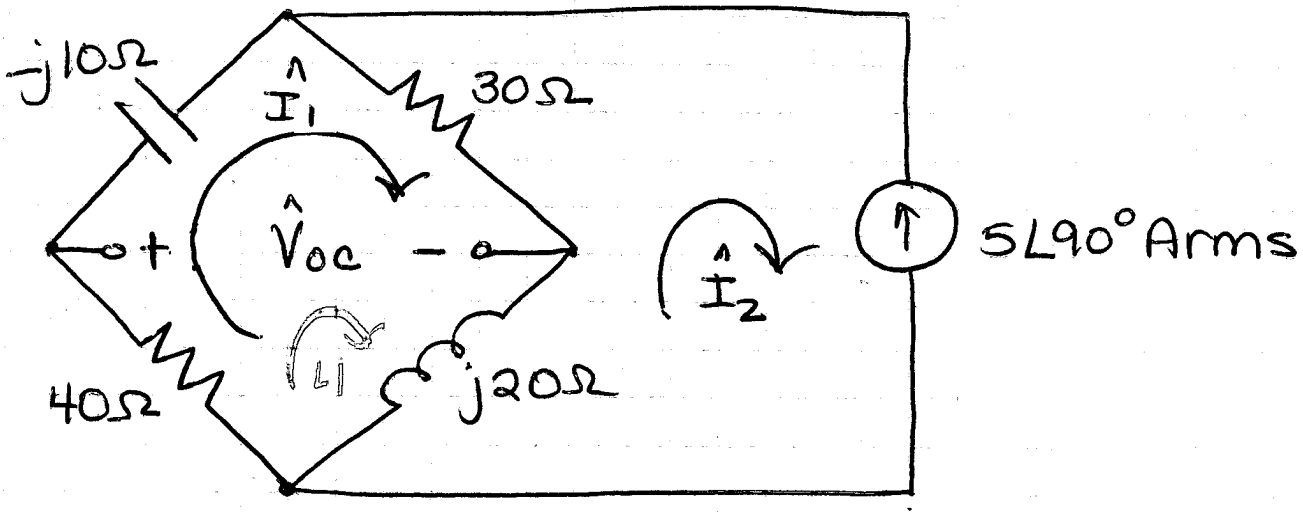
Extra Problems for Exam II Solutions

(1)

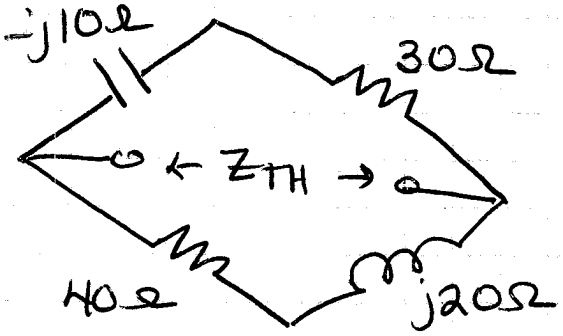


$\hat{I}_2 = 5\angle -90^\circ$ Arms $-(40-j10)\hat{I}_1 - (30+j20)(\hat{I}_1 - \hat{I}_2) = 0$

$\hat{I}_1 = 2.55\angle -64.44$ Arms

KVL at L1: $-40\hat{I}_1 - \hat{V}_{OC} - j20(\hat{I}_1 - \hat{I}_2) = 0$

$\hat{V}_{OC} = 70.72\angle 81.89^\circ$ Vrms



$Z_{TH} = (30-j10)\,||\,(40+j20)$

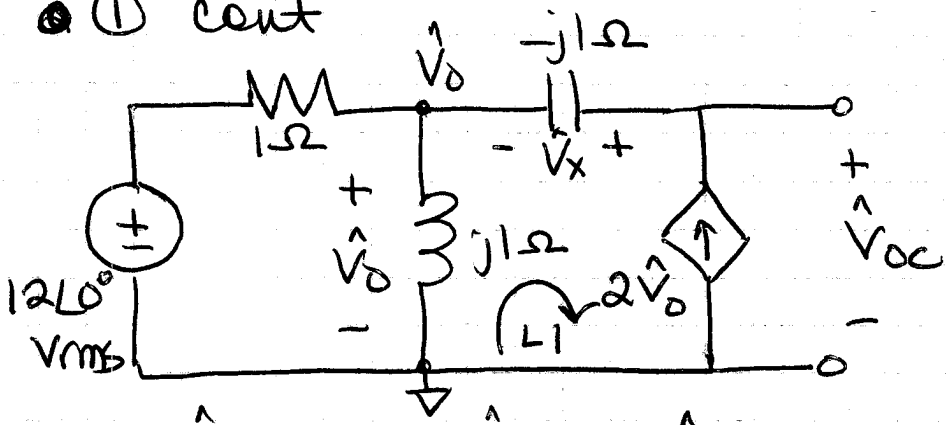
$= 20\ \Omega$

$Z_L = 20\ \Omega$

$P_L = 62.52$ W, Abs

EX prob II

● ① cont



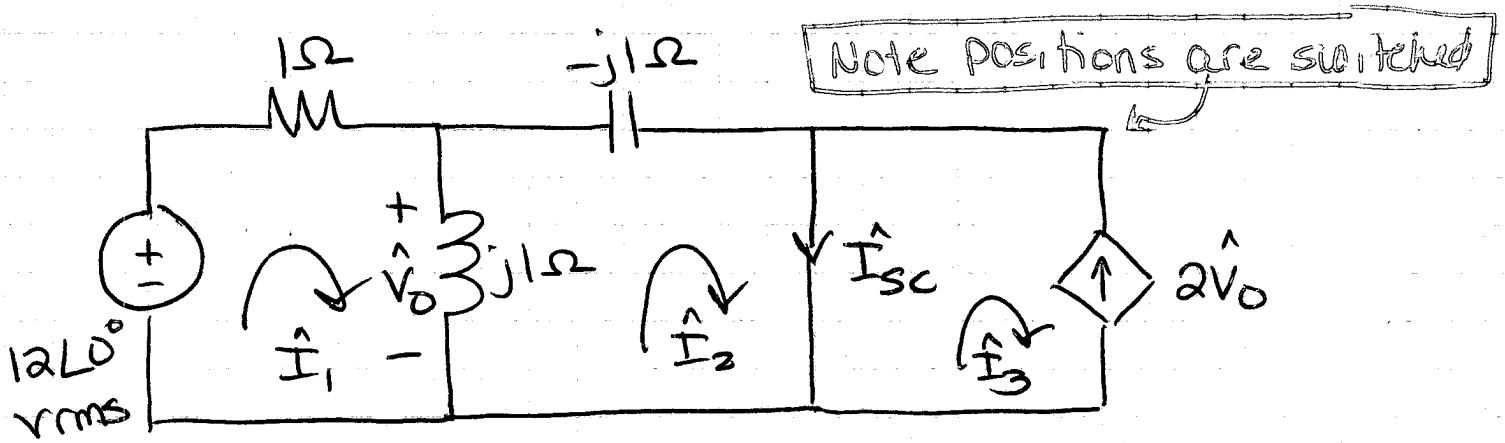
$$\frac{\hat{V}_o - 12}{1} + \frac{\hat{V}_o}{j1} - 2\hat{V}_o = 0$$

$\hat{V}_o = 8.48\angle 135°$ Vrms

$\hat{V}_x = 2\hat{V}_o(-j1)$

by KVL: $\hat{V}_o + \hat{V}_x - \hat{V}_{oc} = 0$

$\hat{V}_{oc} = 18.97\angle 71.57°$ Vrms



know: $\hat{V}_o = j1(\hat{I}_1 - \hat{I}_2)$

$12\angle 0 - \hat{I}_1 - j1(\hat{I}_1 - \hat{I}_2) = 0$

$-j1(\hat{I}_2 - \hat{I}_1) - (-j1)\hat{I}_2 = 0$

$\hat{I}_1(-1-j1) + \hat{I}_2(j1) = -12$

$\hat{I}_1(j1) + \hat{I}_2(0) = 0$

$\hat{I}_1 = 0 \qquad \hat{I}_2 = 12\angle 90°$

$\hat{I}_{sc} = \hat{I}_2 - \hat{I}_3$

$\hat{I}_3 = -2\hat{V}_o$
$= j2(\hat{I}_2 - \hat{I}_1)$

$\hat{I}_3 = 24\angle 180°$ Arms

$\hat{I}_{sc} = 26.83\angle 26.56°$ Arms

$Z_{TH} = .707\angle 45°\ \Omega$

$Z_L = .707\angle -45°\ \Omega$

pg 3 Ex Prob Exam 2

① cont

$$P_L = \left(\frac{18.97}{1}\right)^2 (.5) = 179.90 \text{ W, Abs}$$

②

a) Z_1: $\hat{I}_1 = 66.67 \angle -63.26^\circ$ Arms

$Z_1 = 1.5 \angle 63.26^\circ \Omega$

Z_2: $\hat{I}_2 = 120 \angle -80^\circ$ Arms

$Z_2 = 0.833 \angle 80 \Omega$

Z_3: $\hat{I}_3 = 109.11 \angle -66.42^\circ$ Arms

$Z_3 = 0.92 \angle 66.42^\circ \Omega$

b) $\hat{I}_S = 293.35 \angle -71.21^\circ$ Arms

c) $P_S = 9.45$ kW

d) $\hat{S}_S = 29.34 \angle 71.21^\circ$ kVA

e) $pf_{1-3} = \cos(71.21) = 0.322$ lag

f) $\hat{I}_{Snew} = 99.46 \angle -18.19^\circ$ Arms

$\hat{I}_C = 246.67 \angle 90^\circ$ Arms

$Z_C = 0.405 \angle -90^\circ \Omega$ or $C = 6.55$ mF

g) for $pf = 1$ $\hat{I}_{Snew} = 94.50 \angle 0^\circ$ Arms

max reduction is ~70%

Ex Prob #2

③ Omit this problem. (I didn't give enough info)

④ a) $\hat{V}_{an} = 259.81 \angle 0^\circ$ Vrms

$\hat{V}_{ab} = 450 \angle 30^\circ$ Vrms.

b) Assume Y-Y system

Z_{Y1} : $\hat{I}_{Y1} = 47.37 \angle -49.5^\circ$ Arms ($Z_{Y1} = 5.48 \angle +49.5^\circ \Omega$)

Z_{Y2} : $\hat{I}_{Y2} = 19.25 \angle -60^\circ$ Arms ($Z_{\Delta 2} = 40.49 \angle 60^\circ \Omega$)

Z_{Y3} : $\hat{I}_{Y3} = 50.18 \angle -57.53^\circ$ Arms

($Z_{\Delta 3} = 15.50 \angle 57.53^\circ \Omega$)

$\hat{I}_{aA} = 116.46 \angle -54.68^\circ$ Arms

c) In Y-Y : $V_p = 259.81$ Vrms

$I_p = 116.46$ Arms

In Y-Δ : $V_p = 450$ Vrms

$I_p = 67.24$ Arms

d) $\hat{S}_s = 90.77 \angle 54.68^\circ$ kVA

e) $|\hat{I}_{aAnew}| = 58.23$ Arms $P_s = 52.5$ kW

$pf_{CL} = 1.156$ => No such load exists!

best $pf_{CL} = 1$ $|\hat{I}_{aAnew}| = 67.36$ Arms

$\hat{I}_{aAnew} = 67.36 \angle 0^\circ$ Arms $Z_{yc} = 2.73 \angle -90^\circ \Omega$

④ cont $Z_{\Delta C} = 8.20 \angle -90^\circ \Omega$

⑤ Assume Y-Y first

$\angle Z_{Y\,1-3} = 25.84^\circ$ $\quad \hat{I}_{aA} = 116.39 \angle -25.84^\circ$ Arms

$\hat{V}_{an} = 120.09 \angle 0^\circ$ Vrms

$\hat{V}_{ab} = 208 \angle 30^\circ$ Vrms

$\hat{S}_{3\Phi_{1-3}} = \sqrt{3} V_L I_L \angle 25.84^\circ = 41.93 \angle 25.84^\circ$ kVA

$\hat{S}_{3\Phi_1} = 22.5 \angle 36.87^\circ$ kVA

$\hat{S}_{3\Phi_2} = 10 \angle 53.13^\circ$ kVA

} sum $\Rightarrow \hat{S}_{3\Phi_{1-2}} = 32.22 \angle 41.86^\circ$ kVA

$\hat{S}_{3\Phi_3} = \hat{S}_{3\Phi_{1-3}} - \hat{S}_{3\Phi_{1-2}} = 14.11 \angle -13.21^\circ$ kVA

$14.11 \times 10^3 = \sqrt{3} V_L I_{Y3} \Rightarrow \hat{I}_{Y3} = 39.18 \angle 13.21^\circ$ kVA

$I_{Y3} = 39.18$ Arms

ⓑ $Z_{Y3} = 3.06 \angle -13.21^\circ \Omega$ $\quad$ ⓒ $\hat{S}_{3\Phi_3} = 14.11 \angle -13.21^\circ$ kVA

ⓐ $Z_{\Delta 3} = 9.20 \angle -13.21^\circ \Omega$ $\quad$ ⓔ $P_{3\Phi} = 13.74$ kW

⑥ a) lagging $Q_L > 0$

b) $Q_{3\Phi} = 6$ kVAR $\quad pf = 0.5$ lag $\quad \angle Z_\Delta = 60^\circ$

$I_L = 25$ Arms

⑥ cont

b) $Q_{3\phi} = \sqrt{3} V_L I_L \sin(60^\circ)$

$V_L = 160$ Vrms

c) $\hat{V}_{ab} = 160 \angle 30^\circ$ Vrms

$\hat{V}_{an} = 92.38 \angle 0^\circ$ Vrms

d) $I_p = \frac{I_L}{\sqrt{3}} = 14.33$ Arms

e) $\hat{S}_{3\phi} = \sqrt{3}(160)(25) \angle 60^\circ$

$= 6.93 \angle 60^\circ$ kVA

f) $P_{3\phi} = 3.465$ kW $\quad |\hat{I}_{aA_{new}}| = 20$ Arms

Assume Y-Y $\quad 3.465 \times 10^3 = \sqrt{3}(160)(20)\, pf_{new} \quad pf_{new} = 0.625$ lag

$\angle Z_{YCL} = \cos^{-1}(.625) = 51.31^\circ$

$\hat{I}_{aA_{new}} = 20 \angle -51.31^\circ$ Arms

$\hat{I}_{CY} = (20 \angle -51.31) - (25 \angle -60^\circ)$

$= 6.04 \angle 90^\circ$ Arms

$\boxed{Z_{CY} = 15.29 \angle -90^\circ \Omega}$