Date : Dec. 4, 2003 | Name : EECE 471 | Course : MID TERM 2003

ON MY HONOR, I WILL NOT GIVE OR RECEIVE
ANY ASSISTANCE ON THIS QUIZ OR EXAM.

Signature: ____________________

2.

a) $\phi = \cos^{-1} 0.707 = 45°$

$Q = P \tan\phi = \boxed{500 \text{ kVAr}}$ $\quad S = 500 + j500$ kVA

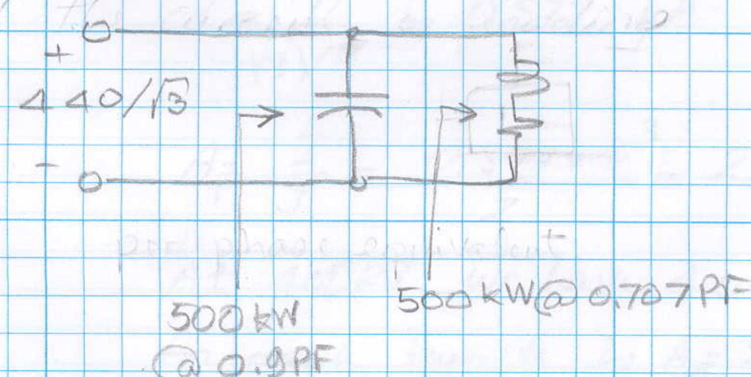
$I = \dfrac{P - jQ}{\sqrt{3}\, V_{ll}} = 0.656 - j\,0.656$ kA $= 0.928 \angle{-45}$

b) $\phi = \cos^{-1} 0.9 = 25.8°$

$Q = P \tan\phi = 500 \times 0.484 = \boxed{242 \text{ kVAr}}$ $\quad$ 80.6 kVAr/phase.

$I = \dfrac{500 - j242}{\sqrt{3}\, 440} = 0.656 - j\,0.318$ kA $= 0.729 \angle{-25.8°}$

c) We need to add a capacitor in parallel with the load:



The reactive power provided by capacitor is:

$Q_c = 500 - 242 = 258$ kVAr. $\quad$ 86 kVAr/phase

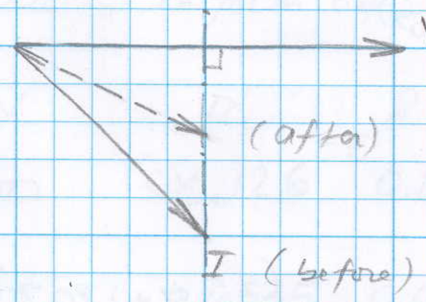
But $Q_c = \dfrac{(V_{ll})^2}{Y_c}$ ... $Q_c = (V_{ll})^2 Y_c \Rightarrow |Y_c| = \dfrac{Q_c}{(V_{ll})^2} = \dfrac{258 \times 10^3}{(440)^2} = 1.33$ S

$|y_c| = \omega C \Rightarrow C = \frac{|y_c|}{2\pi f}$

At $f = 50Hz$

$C = \frac{1.33}{2\times3.14\times50} = 4.23\ mF$

d) Phasor diagram



The compensation improved the overall PF and reduced the magnitude of the current.

3

a)

At 400 kV:

$I = \frac{P}{\sqrt{3}V_{ll}} = 0.577\ kA$

$A_T = \frac{I}{J} = \frac{0.577\times10^3}{2} = 289\ mm^2$

At 400kV we have 4 bundles, and so the area for each bundle is $A_b = 289/4 = 72.2\ mm^2$
$= 142.4$ kcmil

Since this is lower than the smallest in table select smallest: Partridge.

At 220 kV:

$I = 1050\,A$

$A_T = \frac{1050}{2} = 525\ mm^2$

$A_c = \frac{525}{2} = 262.5\ mm^2 = 517.8\ kcmil$

select next higher in the Table: Dove (556.5 kcmil)

b)

Put Results in form of Table:

kV	R_b'	R_b^c	Deq	r^* (m)
400	0.126	0.134	13.5	0.00848 (8.48×10^{-3})
220	0.0535	0.061	9.6	0.01224

* radius estimated based on GMR/0.78 or using $A = \pi r^2$.

KV	R (Ω)	L (mH) H/m	C (μF) F/m
400	15.4	225 (0.935×10^{-6})	2.9 (0.12×10^{-10})
220	14.9	250 (1.04×10^{-6})	2.6 (0.11×10^{-10})

c)

kV	Z (Ω)	Y (μS)	Z_c (Ω)	γ (rad/mile)
400	15.4+j70.7	j911	281 ∠−6.2°	.0017 ∠84°
220	14.9+j78.5	j817	313 ∠−5.4	0.0017 ∠84.5°

d)

	P_{SIL}	P/P_{SIL}
400	569.4	0.702
220	154.6	2.59

P/P_{SIL} is above the 45° line on the capability curve and so will be rejected. Select the 400 kV.

?

4

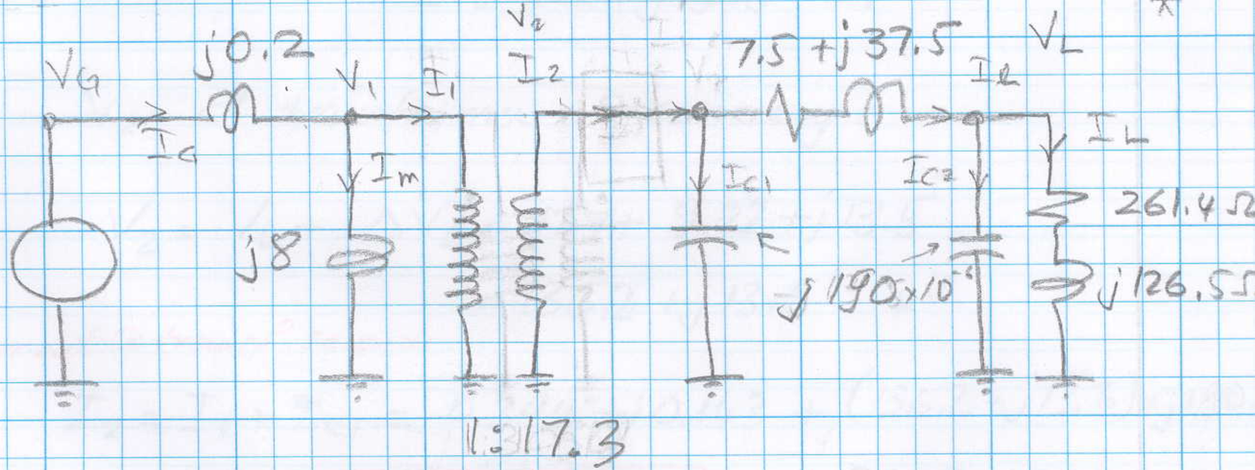
a) Per Phase Equivalent Load Impedance.

$Z_L = \frac{V_{ee}^2}{S^*}$ but $S = P + jQ$

$Q = P \tan\phi = 150 \times \underbrace{\tan \cos^{-1} 0.9}_{0.484} = 150 + j72.6$

$\therefore \; Z_L = \frac{220^2}{150 - j72.6} = 261.4 + j126.5\,\Omega = 290 \angle 25.8^\circ \,\Omega$

b) Per phase Impedance Diagram



$y_c = j3.8 \times 100\times10^{-6} = j380\times10^{-6}$ S $\Rightarrow x_c = -j2.63\times10^3\,\Omega$

$z_l = (0.075 + j0.375)\times100 = 7.5 + j37.5\,\Omega$

$\frac{y_c}{2} = j\frac{380\times10^{-6}}{2} = j190\times10^{-6}$ S

$n = \frac{127}{12.7} = 10$

$n\sqrt{3} = 17.3$

* Disregard 30° phase shift at transformer secondary since this is a normal system.

c)

$V_{ln} = 220/\sqrt{3} = 127$ kV

Calculate series line current

$I_\ell = I_L + I_{C2} = 127\left[(261.4 + j126.5)^{-1} + j190 \times \frac{10^{-6}}{2}\right]$

0.438 $\angle -25.86°$

$= 0.394 - j0.191 + j0.024$

$= 0.394 - j0.167$ kA $= 0.428\angle -23°$

The voltage drop across Line is:

$\Delta V_\ell = Z_\ell \times I_\ell = (0.394 - j0.167)(7.5 + j37.5)$

$= 9.22 + j13.5$ kV

V_2 at transformer secondary:

$V_2 = V_L + \Delta V_\ell = 127 + 9.22 + j13.5$

$= 136.2 + j13.5$ kV

current @ transf. second.:

$I_2 = I_\ell + I_{C1} = 0.394 - j0.143 + (136.2 + j13.5) \times j190 \times \frac{10^{-6}}{2}$

$-0.003 + j0.026$

$= \boxed{0.391 - j0.117 \text{ kA}} = 0.408\angle -16.7°$ kA

primary current:

$I_1 = I_2 \times n\sqrt{3} = \boxed{6.77 - j2.026 \text{ kA}} = 7.067\angle -16.7$ kA

d)

$V_1 = V_2 / n\sqrt{3} = (136.2 + j13.5)/17.3 = 7.86 + j0.78$ kV

$I_G = I_1 + I_m = I_1 + \frac{V_1}{jX_m} = (6.77 - j2.026) + \frac{7.86 + j0.78}{j8}$

$= 6.8 - j2.03 + 0.098 - 0.98j$

$= 6.87 - j3.0$ kA $= 7.50\angle -23.6°$

$V_G = V_1 + I_G (j x_e) = (7.86 + j0.78) + (6.87 - j3)(j0.2)$

$= 8.46 + j2.15 \text{ kV}$

$P_G + jQ_G = 3 V_G I_G^*$

$= 3(8.46 + j2.15)(6.87 + j3) =$

$= 3(51.67 + j40.15)$

$= 155 + j120.5 \text{ MVA}$

e)