Tuğberk Göç
115200084
(#RowN = 14)

1

1) $P_{load} = 400 + 10 \times 14 = 540\ kW$ (#Row Number)

$S_{load} = \frac{P_{load}}{p.f.} = \frac{540}{0.8} = 675\ kVA\ (0.8\ pf_{lagging})$

$S_{base} = 675\ kVA$

$S_{pu} = 1$

$(P_{pu})_{load} = 0.8 \qquad (P_{pu} = S_{pu} . \cos\theta_1)$

after reactive power compensation, real power does not change

$[(P_{pu})_{load}]_{new} = (P_{pu})_{old} = 0.8$

$(I_{new})_{pu} = \frac{(P_{pu})_{new}}{V_{p.u.} . (\cos\theta_1)_{new}}$ ——— ① (V_{pu} doesnot change)

a) ∴ loss is reduce by 10%

$\frac{(I_{pu})^2_{new} . (R_{p.u.})_{line}}{(I_{pu})^2_{old} . (R_{pu})_{line}} = \frac{0.9}{1}$ (losses ratio before and after conpensation)

$(I_{pu})_{new} = \sqrt{0.9}\ (I_{pu})_{old} = 0.9487 . (I_{pu})_{old}$

∴ V_{pu} = rated load = 1

$(S_{pu}) = 1$

$(I_{pu})_{old} = 1$

Thus, $(I_{pu})_{new} = 0.9487$

put in equation ①

$0.9487 = \frac{0.8}{1 \times (\cos\theta_1)_{new}} \longrightarrow (\cos\theta_1)_{new} = 0.843274$

Thus, $(Q_{new})_{pu} = (S_{p.u.}) . (\sin\theta_1)_{new} = 1 . \sqrt{1 - (\cos^2\theta_1)_{new}}$

$(Q_{new})_{pu} = 0.53748$

$(S_{p.u.})_{new} = \frac{0.8}{(\cos\theta_1)_{new}} = \frac{0.8}{0.843274} = 0.94868$

$(S)_{new} = S_{Base} \times (S_{p.u})_{new} = 675 \times 0.94868$

$\boxed{(S)_{new} = 640.359}$

$Q_{new} = 0.53748 \times 675 = 362.799$

$Q_{old} = \sqrt{1-(0.8)^2} \times 675 = 405$

$Q_{cap} = Q_{new} - Q_{old} = -42.201$

$(Q_{cap})_{1-\phi} = \frac{Q_{cap}}{3} = -14.067$ KVAr

b) Improved p.f. $= (\cos\theta)_{new} = 0.843274$

c) $(Q_{cap})_{\Delta} = 3.(Q_{cap})_{star} = -3 \times 42.201 = -126.603$

$(Q_{new})_{load} = (Q_{cap})_{*} + (Q_{old})_{load} = 405 - 126.603$

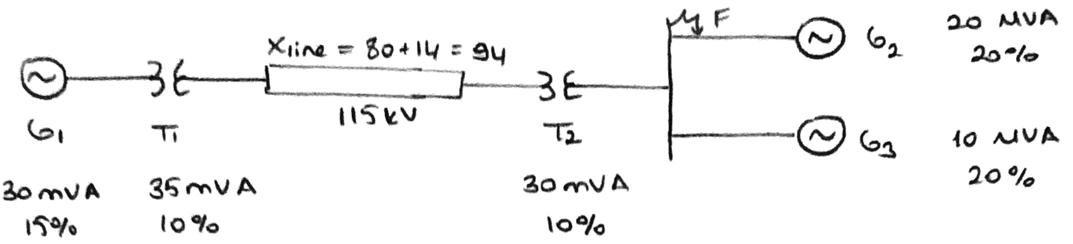
$(Q_{new})_{load} = 278.397$

New Power Factor $= \cos\theta' = \cos(\tan^{-1}(Q/P))$

$= \cos\left(\tan^{-1}\left(\frac{278.397}{540}\right)\right)$

$= 0.889$ (lag)

2)



Base MVA = 30 MVA   Base voltage on Transmission Line = 115 kV

For; $\underline{G_1}$

$$X_{new} = X_{old} \times \left(\frac{MVA_{new}}{MVA_{old}}\right) \cdot \left(\frac{kV_{old}}{kV_{new}}\right)^2$$

$$= 0.15 \times \frac{30}{30} = 0.15 = 15\%$$

$\underline{T_1}$

$$X_{new} = 0.10 \times \frac{30}{35} = 8.5\%$$

Transmission Line —

$$Z_{base} = \frac{(kV)_B^2}{(MVA)_{base}} = \frac{(115k)^2}{30} = 440.83\,\Omega$$

$$X_{pu} = \frac{X_{actual}}{Z_{base}} = \frac{94}{\underset{\downarrow \; 440.83}{Z_{base}}} = 0.213 = 21.3\%$$

$\underline{T_2}$

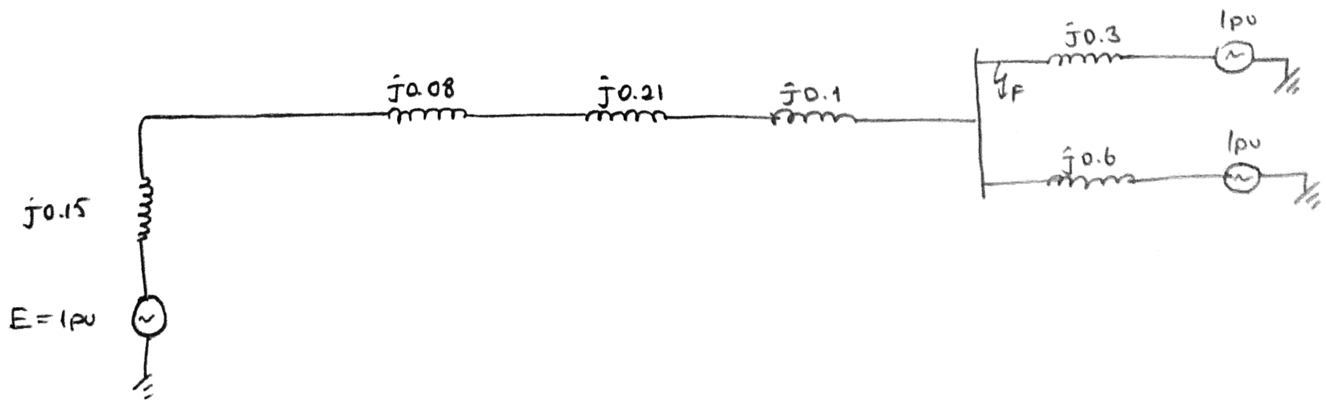
$$X_{new} = 0.1 = 10\%$$

$\underline{G_2}$

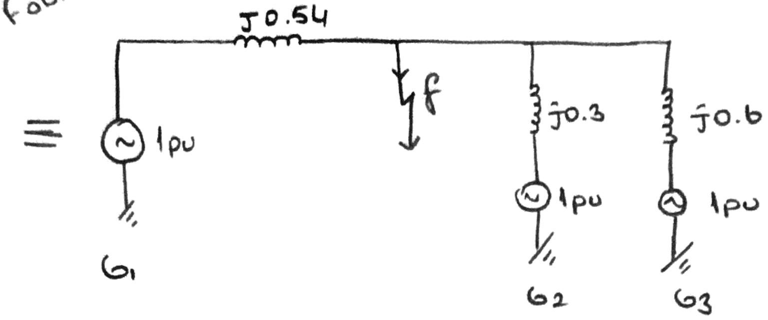
$$X_{new} = 20\% \cdot \frac{30}{20} = 30\%$$

$\underline{G_3}$

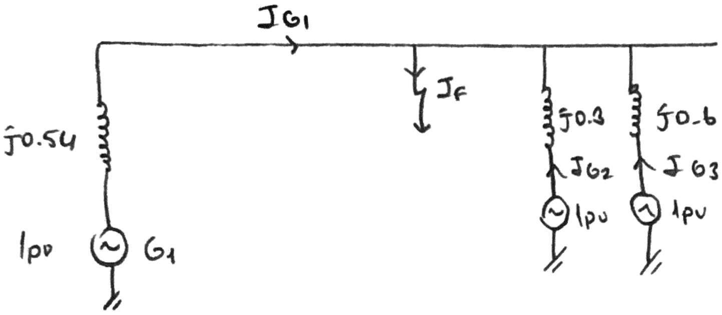
$$X_{new} = 20\% \cdot \frac{30}{10} = 60\%$$



Fault at F point



Equivalent



a) Fault Current

$$I_f = I_{G1} + I_{G2} + I_{G3} = \frac{1}{j0.54} + \frac{1}{j0.3} + \frac{1}{j0.6} = j6.83\,pu$$

$$\boxed{I_f = 6.83\,pu}$$

b) Supplied by G1 Generator

$$I_{G1} = \frac{1}{j0.54} = j1.85 \qquad \boxed{|I_{G1}| = 1.85\,pu}$$

3) 17-22 peak hours : for off-peak = 0.2 \$/kwh

the savings are equal

1st DR program thresold → 2kw price for on-peak = 0.4 \$/kwh

2nd DR program thresold → $(2.5 + 0.02 \times 14)$ kw price for on-peak

For 1st DR program shifted energy $= (18-17).(3-2) + (21-18).(4-2)$

$= 7$ kwh

Cost saving $= 7$ kwh $\times (0.4 - 0.2)$ \$/kwh $= 1.4$ \$

For 2nd DR program shifted energy $= (18-17).(3-2.78) + (21-18).(4-2.78)$

$= 0.22 + 3.66$

$= 3.88$ kwh

Cost saving $= 1.4$ \$ $= 3.88$ kwh $\times (p - 0.2)$ \$/kwh

$\boxed{p \hat{=} 0.5608 \text{ \$/kwh}}$ → on-peak energy price for 2nd DR program.