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1a) $E_a = V_t - jI_a X_s$

$V_t = 415V$, $S = 25KVA = 25000VA$

$V_t = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}} = 239.6V$

$X_s = 1.5\Omega$; $pf = 0.8$ lagging

$\therefore \theta = \cos^{-1}(0.8)$
$= 143.13°$

$I_a = \frac{S}{V_L\sqrt{3}} = \frac{25000}{415 \times \sqrt{3}} = 34.78A \angle 143.13°$

$E_a = 239.6 - j[(34.78\angle 143.13°)(1.5)]$

$E_a = 270.90 + j41.74$

$E_a = 274.098V \angle 8.76°$

1b) A 20% increase $= 1+0.2$
$= 1.2$

$\delta = 8.76$

$E_a' = 1.2 \times 274.098$
$= 328.92V$

$\therefore \frac{V_t E_a}{X_s} \sin\delta = \frac{V_t E_a'}{X_s} \sin\delta'$

$\therefore \sin\delta' = \frac{E_a}{E_a'} \sin\delta \Rightarrow \frac{274.098}{328.92V} \times \sin 8.76°$

$\sin\delta' = 0.1269$

$\therefore \delta' = \sin^{-1}(0.1269)$

$\delta' = 7.29$

) $I_A' = \frac{E_a' - V_t}{jX_s}$

1b.) $I_A' = \frac{E_a' - V_t}{jX_s} = \frac{328.92\angle 7.29° - 239.6\angle 0}{j1.5}$

$= 27.82 - j57.77$

1bii) power factor $= \cos(-64.28°)$

$= 0.434$ lagging

1biii) $Q = 3V_t I_a \sin\theta$

$= 3 \times 239.6 \times 64.13 \times \sin(64.28)$

$= 41529.65$ VAR

1c) At max power $\delta = 90°$

$P_{max} = \frac{3E_a V_t}{X_s} = \frac{3 \times 274.098 \times 239.6}{1.5}$

$= 131347.76$ kw

$= 131.347$ kw

$I_{max} = \frac{E_a - V_t}{jX_s} = \frac{274.098\angle 90° - 239.6\angle 0}{1.5j}$

$= 242.71A \angle 41.16°$

power factor $= \cos(41.16°)$

$= 0.7529$ leading

$Q_{max} = 3V_t I_{amax} \sin(41.16°)$

$= 3 \times 239.6 \times 242.71 \times 0.6582$

$= 114829.54$ VAR.