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

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

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

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

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

$E_a = 270.90 + j41.74$

$E_a = 274.098V \angle 8.76^\circ$

b The field excitation current I_f is increased by 20% without changing the power ~~output~~ input from the prime mover. Find the stator current I_a, power factor and reactive power Q supplied by the machines

$\therefore$ 20% increase = $1+0.2 = 1.2$

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

$\sin\delta' = 0.1269$

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

$\delta' = 7.29^{\circ}$

i $I_A' = \frac{E_a' - V_t}{jX_s} = \frac{328.92\angle 7.29^{\circ} - 239.6\angle 0}{j1.5}$

$= 27.82 - j57.77$

$I_A' = 64.13A\angle -64.28^{\circ}$

ii $P.f = \cos(-64.28^{\circ}) = 0.434$ lagging.

iii $Q = 3V_t I_a \sin\theta = 3 \times 239.6 \times 64.13 \times \sin(64.28)$

$41529.65 VAR$

C At maximum power $\delta = 90^{\circ}$

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

$= 131347.76W = 131.347 kW$

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

$= 242.71A\angle 41.18^{\circ}$

$P_f = \cos(41.18^{\circ}) = 0.753$

$Q_{max} = 3 \times 239.6 \times 242.71 \times 0.6582$

$= 114829.54 VAR$

$= 114.829 kVAR$