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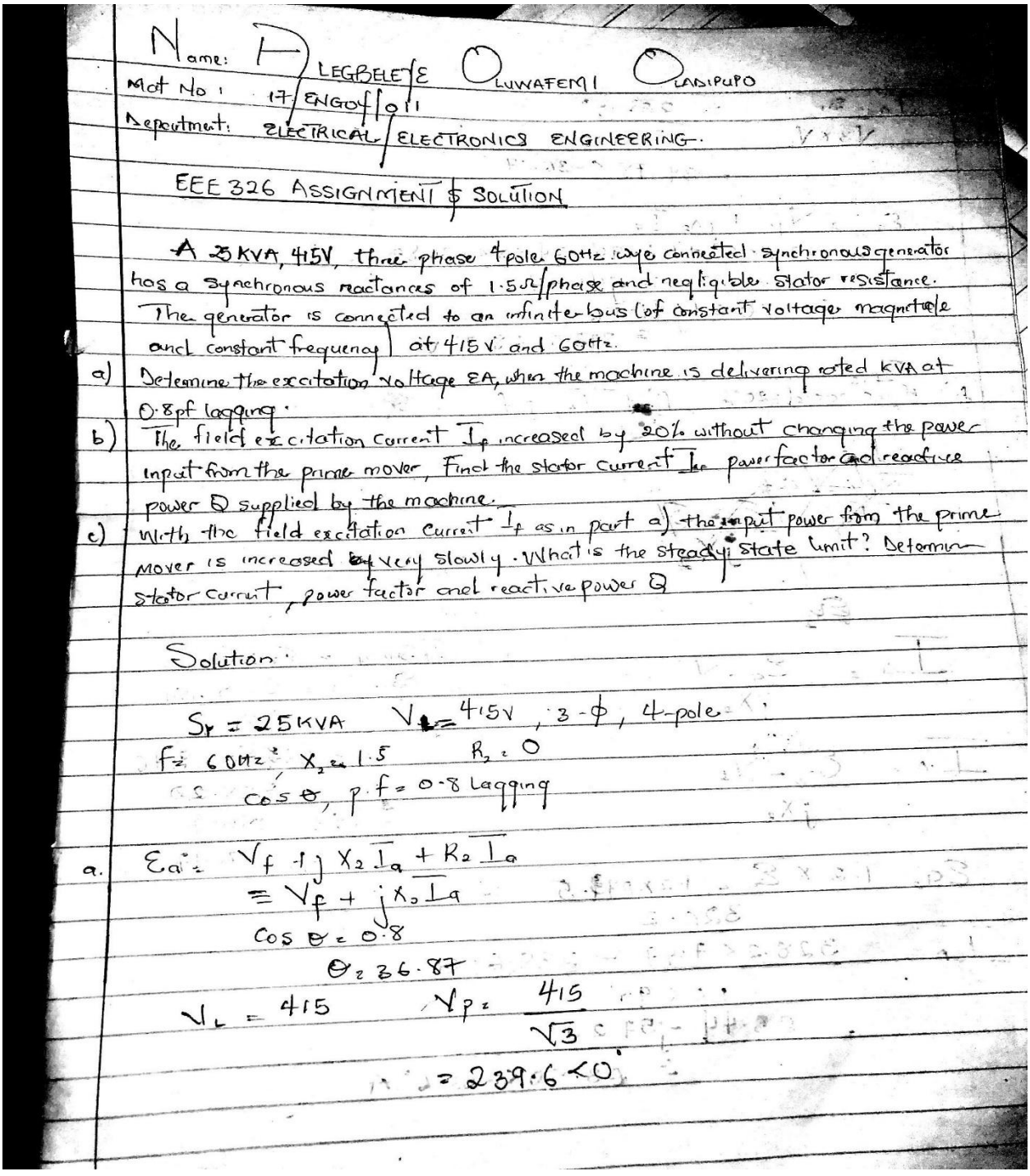
EEE 326 ASSIGNMENT



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EEE 326 ASSIGNMENT & SOLUTION

A 25 KVA, 415V, three phase 4pole 60Hz wye connected synchronous generator has a synchronous reactances of 1.5Ω/phase and negligible stator resistance. The generator is connected to an infinite-bus (of constant voltage magnitude and constant frequency) at 415 V and 60Hz.

a) Determine the excitation voltage E_A, when the machine is delivering rated kVA at 0.8pf lagging.

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

c) With the field excitation current I_f as in part a) the input power from the prime mover is increased very slowly. What is the steady state limit? Determine stator current, power factor and reactive power Q

Solution:

$S_r = 25\text{KVA}$ $V_L = 415\text{V}$, 3-ϕ, 4-pole
$f = 60\text{Hz}$ $X_s = 1.5$ $R_a = 0$
$\cos\theta$, p.f = 0.8 lagging

a. $E_a = V_f + j X_s \bar{I}_a + R_a \bar{I}_a$
$= V_f + j X_s \bar{I}_a$
$\cos\theta = 0.8$
$\theta = 36.87$
$V_L = 415$ $V_p = \frac{415}{\sqrt{3}}$
$= 239.6 \angle 0$

$$I_a = \frac{S_r}{\sqrt{3} \times V_L} = \frac{25 \times 10^3}{\sqrt{3} \times 415}$$

$$= 34.78 \angle -36.87$$

$$E_a = V_p + jX_s I_a$$

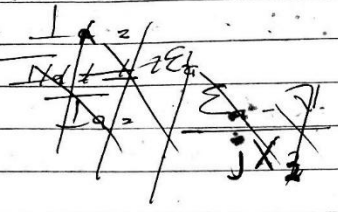
$$= 239.6 \angle 0^\circ + 1.5 \angle 90^\circ \times 34.78 \angle -36.87$$

$$= 270.3 + j41.74$$

$$= 270.3 + j41.74$$

$$= 273.51 \angle 8.7^\circ \text{ V}$$

(b) If I_f is increased by 20%, find I_A, p.f & Q



E_{a_2}

$$I_a = \frac{E_a - V}{jX_s}$$

$$I_A = \frac{E_{a_2} - V_L}{jX_s}$$

$$E_{a_2} = 1.2 \times E_a = 1.2 \times 273.5$$

$$328.2$$

$$I_A = \frac{328.2 \angle 7.47 - 239.6 \angle 0}{1.5 \angle 90^\circ}$$

$$= 28.44 - j57.20$$

$$= 63.90 \angle -63.6^\circ \text{ A}$$

$E_1 \sin S_1 = E_2 \sin S_2$

$\sin S_2 = \frac{E_1 \sin S_1}{E_2}$

$= \frac{273.5 \sin 8.7}{328.20}$

$\sin S_2 = 0.127$

$S_2 = 7.47$

(i) p.f = $\cos\theta$

$\cos(-63.6)$

$= 0.4$ Lagging

(ii) $Q = \sqrt{3} \times V_L \times I_L \times \sin\theta$

$\sqrt{3} \times 415 \times 63.90 \times \sin 63.6$

41141.29

≈ 41.4 KVAR

$= 41.4$ KVAR

(c) $\overline{I}_{A_3} = \dfrac{\mathcal{E}_{a_3} - V}{jX_2}$

Since its using the same condition as in (a)

$= \dfrac{273.51 \angle 90^\circ - 239.6 \angle 0^\circ}{1.5 \angle 90^\circ}$

$= 182.34 + j159.73$

$\therefore I_{A_3} = 242.4 \angle 41.21^\circ$ A

(i) p.f = $\cos\theta$

$= \cos(41.21)$

$= 0.75$ leading

(ii) $Q = \sqrt{3} \times V_L \times I_L \times \sin\phi$

$\sqrt{3} \times 415 \times 242.4 \times \sin 41.21$

114791.21

≈ 115 KVAR