Solution Key

جامعة بيرزيت

BIRZEIT UNIVERSITY

Electrical and Computer Engineering Department

Electrical Machines ENEE 2408

Short Exam # 3 (10*mins*)

Student Name: **ID:** **May 31, 2023**

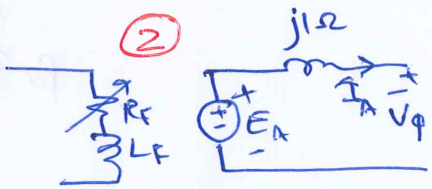
A 10MVA, 11kV, 0.8 lagging Power factor, 6 poles, Y-connected synchronous generator has a synchronous reactance of 1Ω and negligible armature resistance. If the generator is operating in parallel with a large power system (infinite bus), whose rated line to line voltage is 11kV and frequency is 50Hz, then:

a) What is the speed of rotation of the prime mover in rad/s and in rpm?
b) Draw the per-phase equivalent circuit of the generator
c) What is the magnitude of the internally generated voltage E_a at rated conditions, what is the torque angle at rated conditions?
d) What is the static stability limit of the generator?
e) Draw the phasor diagram at rated condition and Static stability limit condition

$V_L = 11KV$, $V_\varphi = 6351V$

a) $n_s = \frac{120 fe}{P} = \frac{120(50)}{6} = 1000 rpm$ (1) , $\omega_s = \frac{1000 \times 2\pi}{60} = 104.72 rad/s$ (1)

b)



c) $\bar{E}_A = \bar{V}_\varphi + jX_s \bar{I}_A$

$= 6351 + j1 \bar{I}_A$, but

$\bar{I}_A = \frac{S}{\sqrt{3} V_L} \angle -\cos^{-1} PF$ (1)

$= \frac{10 MVA}{\sqrt{3}\, 11K} \angle -36.87 A$

$= 524.86 \angle -36.87 A$

$\bar{E}_A = 6351 + (1\angle 90^\circ)(524.86 \angle -36.9)$

$\bar{E}_A = 6351 + 524.86 \angle +53.13$

$= 6351 + 314.9 + j\,419.9$

$= 6665.9 + j\,419.9 = 6679.1 \angle 3.6\ V$

(1) $\therefore |E_A| = 6679.1V$, (1) $\delta = 3.6^\circ$

d) $P_{max}|_{\delta=90} = \frac{3 V_\varphi E_A}{X_s} = \frac{3(6351)(6679.1)}{1} = 127,256,892.9\ W$ (1)

(e)