

# KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

## ELECTRICAL ENGINEERING DEPARTMENT

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EE-360

Quiz 5

ser#:

I.D.:

Name:

A 1500-KVA, 2300-V, 60-Hz, Y-Connected alternator (synchronous generator) is tested in order to determine its voltage regulation. The results of these tests are:

Open-Circuit Test:  $I_F = 28 \text{ A}$   $V_{Loc} = 900 \text{ V}$

Short-Circuit Test:  $I_F = 28 \text{ A}$   $I_{Lsc} = 377 \text{ A}$

DC-Resistance Test:  $I_{DC} = 100 \text{ A}$   $V_{DC} = 32 \text{ V}$

Assume the effective armature resistance  $R_a = 1.5 \times R_{DC}$ . Calculate (the full-load voltage regulation for 0.8 lagging power factors. Draw the phasor diagram for this condition and indicate whether the machine is over or under excited.

From the open-circuit + short circuit tests

$$|Z_s| = \frac{E_{oc(ph)}}{I_{sc,ph}} = \frac{900}{377} = 1.378 \Omega$$

From the DC-test:

$$R_{dc} = \frac{V_{dc}}{2I_{dc}} = \frac{32}{200} = 0.16 \Omega$$

$$R_a = 1.5 \times R_{dc} = 0.24 \Omega$$

$$X_s = \sqrt{Z_s^2 - R_a^2} = \sqrt{(1.378)^2 - (0.24)^2} = 1.36 \Omega$$

% VR =  $\frac{E_a - V_{t,FL}}{V_{t,FL}} \times 100\%$

$$E_a = \sqrt{(V_t \cos \theta + I_a R_a)^2 + (V_t \sin \theta + I_a X_s)^2} \quad \text{--- (A)}$$

$I_{a,FL} = \frac{1500 \times 10^3}{\sqrt{3} \times 2300} = 377 \text{ A}$  ;  $V_t = \frac{2300}{\sqrt{3}} = 1328 \text{ V}$

at 0.8 p.f. lag:

$$E_a = \sqrt{(1328 \times 0.8 + 377 \times 0.24)^2 + (1328 \times 0.6 + 377 \times 1.36)^2} = 1745$$

% VR =  $\frac{1745 - 1328}{1328} \times 100\% = 31.4\%$