	University of Ruhuna **Faculty of Engineering**	**EE 6303 Electrical Machines and Drives**
Dep. of Electrical and Information Engineering		**Exercise 1: Synchronous Generators**
		Deadline NA

1) Two 6600 V, Y connected generators in parallel supply the following loads.
   400 kW at 1 power factor
   400 kW at 0.85 power factor lagging
   300 kW at 0.8 power factor lagging
   800 kW at 0.7 power factor lagging
   One generator supplies I_A = 100 A at 0.9 power factor lagging. Find the current and the power factor of the other generator.
   (Answers: 103 A, 0.74 lagging)

2) Two similar 400 V, 3-phase generators share equal kW power delivered to a balanced 3-phase, 50 kW, 0.8 power factor lagging load. If the power factor of one machine is 0.9 lagging, find the power factor and the current supplied by the other generator.
   (Answers: 51.4 A, 0.7 lagging)

3) Two generators (G1 and G2) connected in parallel with the grid supply a load of 8 MW, 0.92 power factor lagging. The two generators supply 80% of the active power demand of the load and 100% of the reactive power demand of the load. The no-load set points of G1 are 52 Hz, and 12.2 kV. The frequency droops of G1 and G2 are 1.4 MW/Hz and 1.3 MW/Hz, respectively. The voltage droops of G1 and G2 are 1.1 MVAr/V and 1.2 MVAr/V, respectively. The frequency and the voltage of the grid are 50 Hz and 11 kV respectively.
   a. Calculate the active and reactive power outputs of the two generators.
   b. Determine the no-load frequency and the no-load voltage set points of G2.
   c. During a grid failure, the two generators and the load will be disconnected from the grid so that the load is supplied by the two generators alone. Determine the frequency and the voltage of the system when the system is operating in isolated mode.
   d. How can the frequency of the isolated system be restored to 50 Hz when the system is not connected to the grid?

   (Answers: a) 2.8 MW, 1.32 MVAr, 3.6 MW, 2.088 MVAr, b) 52.77 Hz, 12.74 kV, c) 49.41 Hz, 11 kV, d) change $f_{nl,G1}$ = 53.14 Hz or $f_{nl,G2}$ = 54 Hz)

4) A 1.2 kV, 50 Hz, star connected synchronous generator is rated at 150 kVA, 0.8 power factor lagging. It has synchronous reactance of 2.72 Ω per phase. Assume that the generator is connected to a turbine capable of supplying power up to 145 kW. The maximum no-load voltage of the generator is 1.25 kV. Using the capability curve drawn above, find out

whether the generator is capable of supplying a line current of 70 A at 0.85 power factor lagging.

5) A 3-phase, 400 V, Y connected salient pole synchronous generator supplies current of 10A at 0.94 pf lagging. Find the load angle and direct and quadrature axis component of the armature current if $X_d = 10\Omega$ and $X_q = 6.5\ \Omega$. Armature resistance is negligible.
(Answers: 8.23^0, 4.73 A, 8.81 A)

6) A 3-phase star connected, 50 Hz synchronous generator has direct-axis synchronous reactance of 0.45 pu. The generator delivers rated kVA at rated voltage. Draw the phasor diagram at full-load 0.8 pf lagging and calculate the open circuit voltage and voltage regulation. Resistive voltage drop at full-load is 0,015 pu.
(Answers: 1.45 pu, 45%)

7) A 3-phase, 400 V(line), Y-connected, salient pole synchronous generator supplies a current with a phase angle of 30^o lagging. The direct and quadrature axis components of the synchronous reactance are $X_d = 10\ \Omega$, $X_q = 6.5\ \Omega$, armature resistance is negligible. If the load angle is 14^o, calculate
    a. The direct and quadrature component of armature current.
    b. The no-load voltage and the percentage regulation.
    c. The output power.
    d. If the load current is kept constant but the phase angle becomes 10^o lagging, find the new values of the no-load voltage and the load angle.

   (Answers: a) 8.3 A, 8.6 A, b) 307.2 V(phase), 32.9%, c) 7.2 kW, d) 275 V(phase), 17.4^o)