

NATIONAL UNIVERSITY OF SINGAPORE
Department of Electrical Engineering
EE2029 INTRODUCTION TO ELECTRICAL ENERGY SYSTEMS
(Tutorial: Generator)

1. At what speed must a six-pole three-phase synchronous generator run to generate 50-Hz voltage?
(Answer: 1000 rpm)

2. Calculate the excitation voltage for a three-phase wye-connected 2500 kVA, 6.6 kV synchronous generator operating at full load and 0.9 p.f. lagging. The per phase synchronous reactance is 4Ω and the per phase armature resistance is negligible. What will be the internal excitation voltage when the generator is operating at full load with 0.9 p.f. leading? Explain whether the machine is overexcited or underexcited in each case.
(Answer: $4265.11\angle 10.64^\circ$ V overexcited, $3518.42\angle 12.93^\circ$ V underexcited)

3. A 1MVA 11kV three-phase wye-connected synchronous generator has a synchronous reactance of 5Ω and a negligible armature resistance. At a certain field current, the generator delivers rated load at 0.9 lagging power factor at 11kV. For the same excitation, what is the armature current and power factor when the input torque is reduced such that the real power output is half of the previous case?
(Answer: $33.34\angle -44.88^\circ$ A, 0.71 lagging)

4. An 11kV three-phase wye-connected generator has a synchronous reactance of 6Ω per phase and a negligible armature resistance. For a given field current, the open-circuit line-to-line excitation voltage is 12kV. Calculate the maximum power developed by the generator. Determine the armature current and power factor at the maximum power condition.
(Answer: 22 MW, $1566.43\angle 42.51^\circ$ A, 0.74 leading)

5. Two three-phase generators (G1 and G2) supply a three-phase load through separate three-phase lines as shown in Fig. 1 below.

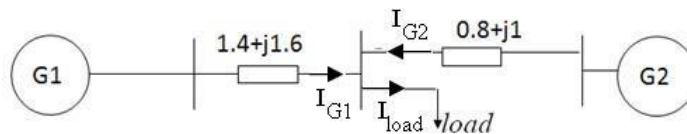


Fig. 1 Single-line diagram of a three-phase circuit

Each generator has a synchronous reactance of 3Ω per phase and a negligible armature resistance. The three-phase Y-connected load absorbs 30 kW at 0.8 power factor lagging. The line impedance is $1.4 + j1.6\Omega$ per phase between generator G1 and the load, and $0.8 + j1\Omega$ per phase between generator G2 and the load. If generator G1 supplies 15 kW at 0.8 power factor lagging, with terminal voltage of 460 V line-to-line, assume balanced operation, determine internal excitation voltage magnitude (per phase) and power angle of both generators. Use terminal voltage of generator 1 as a reference angle.

(Answer: For G1, 313.07 V, 10.39° , For G2, 335.73 V, 12.74°)