ECE470 POWER SYSTEMS I

Homework Set 3

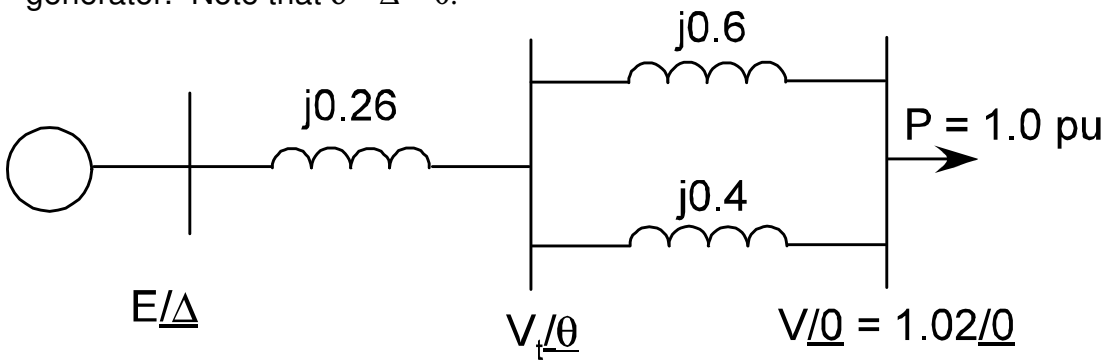
1. A three-phase, 9 MVA, 12.48 kV, wye-connected synchronous generator has an armature resistance and synchronous reactance of 1.5 + j25 Ω per phase. Determine the voltage regulation if the power factor is:
   a) 0.8 leading. b) Unity. c) 0.8 lagging.

2. A three-phase, 200 MVA, 24 kV, 1800 rpm synchronous generator has a synchronous reactance of 4.61 Ω per phase and negligible armature resistance.
   a) The field current is adjusted to obtain the rated terminal voltage at open circuit. Determine the excitation voltage.
   b) A short circuit occurs across the machine terminals. Find the stator current.
   c) The synchronous machine is connected to an infinite bus. The generator delivers its rated current at 0.8 power factor lagging. Determine the excitation voltage.
   d) Calculate the maximum power the synchronous machine can deliver for the excitation current of part (c).

3. An overexcited synchronous motor is connected across a 250-kVA inductive load of 0.6 lagging power factor. The motor takes 20 kW while running on no load. Calculate the kVA rating of the motor in order to raise the overall power factor of the motor-inductive load combination to 0.95 lagging.

4. A small industrial plant has a total electrical load of 300 kW at 0.6 lagging power factor. A 50-hp pump is to be installed. A synchronous motor operating at power factor of 0.8 leading is selected to drive the pump. Neglect all losses in the synchronous motor. Calculate:
   a) the new total load real and reactive powers, and
   b) the resultant power factor.

5. In the system shown below, the infinite bus voltage is held at 1.02 pu while the generator excitation is held at 0.95 pu. The generator supplies rated power. Determine the power factor at the generator terminals and the load angle of the generator. Note that $\delta = \Delta - \theta$.



6. A 600 V, 60 Hz, 60 kVA, Y-connected, eight-pole, salient-pole generator supplies rated load at 0.8 lag power factor and rated voltage. Neglect armature resistance, $X_d = 9\ \Omega$, $X_q = 5\ \Omega$. Determine:
   a) E_f and δ,
   b) Active power developed, and
   c) Driving Torque if the rotational losses are 4 kW.

7. A salient-pole synchronous generator has a direct-axis synchronous reactance of 1.0 per unit and a quadrature-axis reactance of 0.6 per unit. Neglect saturation. The generator delivers full-load current at rated terminal voltage and 0.866 lagging power factor.

a) Draw the phasor diagram.
b) Determine the excitation voltage.