1. A 3-Φ, 5 KVA, 208 V, four-pole, 60 Hz, star-connected synchronous machine has negligible stator winding resistance and a synchronous reactance of 8 ohms per phase at rated terminal voltage. The machine is first operated as a generator in parallel with a 3-Φ, 208 V, 60 Hz power supply.

(a) Determine the excitation voltage and the power angle when the machine is delivering rated KVA at 0.8 PF lagging. Draw the phasor diagram for this condition.

(b) If the field excitation current is now increased by 20% (without changing the prime mover power), find the stator current, power factor, and reactive kVA supplied by the machine.

(c) With the field current as in (a) the prime mover power is slowly increased. What is the steady-state (or static) stability limit? What are the corresponding values of the stator (or armature) current, power factor, and reactive power at this maximum power transfer condition?

2. A 3-Φ, 100 –hp, 60-Hz, 480-V, four pole, and wye-connected, cylindrical rotor synchronous motor has an armature resistance of 0.15 ohms and a synchronous reactance of 2 ohms per phase, respectively. At the rated load and a leading power factor of 0.8, the motor efficiency is 0.95. Determine the following:

(a) The internal generated voltage.

(b) The torque angle.

(c) The maximum torque.

3. A 3-Φ, 13.2 kV, 60-Hz, 50 MVA, wye-connected cylindrical rotor synchronous generator has an armature reactance of 2.19 ohms per phase. The leakage reactance is 0.137 times the armature reactance. The armature resistance is small enough to be negligible. Also ignore the saturation. Assume that the generator delivers full – load current at the rated voltage and 0.8 lagging power factor. Also, assume that the machine has 8 poles. Determine the following:

(a) The synchronizing power in MW per electrical radian.

(b) The synchronizing power in MW per mechanical degree.

(c) The synchronizing torque in MW per mechanical degree.

4. The generator in the figure below operates at rated terminal conditions with a power factor of 0.8 lagging. The reactance Xd = 0.7 pu (on the generator ratings).

(a) Find the P, Q, Ef and torque angle. Draw the phasor diagram.

(b) The steam value is opened further so that P increases 20 %. Reevaluate P, Q, Ef and torque angle. Draw the new phasor diagram.

(c) The system is restored to the conditions in (a). The exciter is adjusted to raise Ef 20%. Reevaluate P, Q, Ef and torque angle. Draw the new phasor diagram.