ECE 3600 homework # 12 Due: Tue, 10/27/09

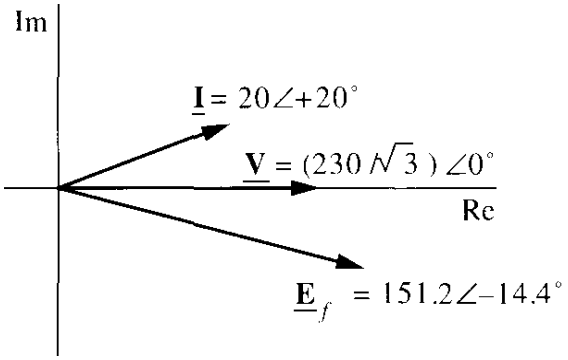
1. A single-phase generator delivers a voltage of 680 V rms at its terminals and a current of 32 A rms. The real power delivered is 15 kW.
   Find the reactive power Q. Give both possible answers.

2. A 3-phase synchronous generator operates onto a grid bus of voltage 12 kV (line value). The synchronous reactance is 5 Ω/phase. The magnitude of the generator emf equals the magnitude of the bus voltage. The machine delivers 18 MW to the grid. Find:
   a) The power angle, δ.
   b) The complex phase current, (Assume the bus voltage phase angle is 0^o).
   c) The magnitude and direction of reactive power.

ECE 3600 homework # 13 Due: Fri, 10/30/09

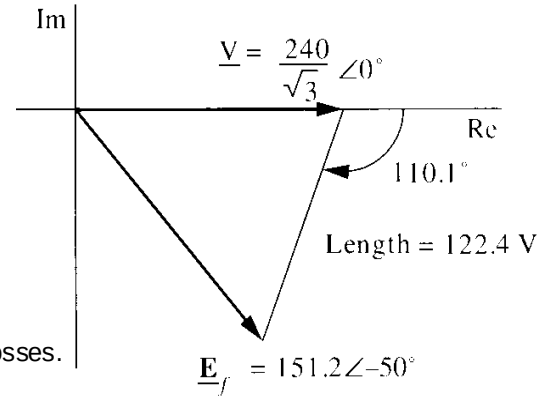
1. A 60 Hz, 2-pole, 3-phase synchronous generator supplies power to a 12.5 kV bus. The synchronous reactance is 4 Ω/phase. The generator emf is 7 kV $\angle 20^o$ (the angle is referenced to the terminal voltage). Find the following.
   a) The total power generated.
   b) The total reactive power generated.
   c) The shaft torque from the prime mover, neglecting friction.
   d) Increase the magnitude of the generator emf so that Q := 0·VAR The prime mover torque does not change. Note: If the prime mover torque doesn't change, neither does P. δ can change.
   e) The new power angle, δ.
   f) Increase the magnitude of the generator emf so that Q := 9·MVAR
   g) The new power angle, δ.

2. 4.39 Refer to the per-phase phasor diagram at right. It is for a 12-pole, three-phase synchronous machine.
   a) Is the machine operating as a motor or a generator?
   b) What is the voltage and apparent power into/out of the machine?
   c) Determine the synchronous reactance of the machine.
   d) For the same real power, what magnitude of excitation voltage yields unity power factor?



3. 4.41. A cylindrical-rotor, 60-Hz, three-phase, 12-pole synchronous motor operates from 2300 V and produces 500 hp. The motor operates with unity power factor with an excitation voltage of E = 1620 V per phase. Neglect losses. Determine the following:
   a) The current.
   b) The synchronous reactance.
   c) The torque.
   d) The rotor power angle.

4. 4.43. The per-phase phasor diagram for a three-phase, 60-Hz, 8-pole synchronous motor is shown. Note that all sides and two angles of the triangle are shown. The current/phase is 21 A
   a) Is the motor overexcited or underexcited?
   b) What is the rotor power angle?
   c) What is the power factor and is it leading or lagging?
   d) Determine the synchronous reactance per phase.
   e) Determine the output power and torque, neglecting mechanical losses.



Answers

1. ± 15.8 kVAR 2. a) 38.68·deg b) 918·A / 19.34·deg c) - 6.32·MVAR

1. a) 12.96·MW b) - 3.459·MVAR c) $3.437\cdot 10^4$·N·m d) 7.604·kV e) 18.35·deg f) 9.197·kV g) 15.1·deg
2. a) motor b) 132.8·V 7.97·kVA c) 2·Ω d) E_{af} = 138·V
3. a) 93·6·A b) 9.92·Ω c) 5934·N·m d) 34.95·deg
4. a) underexcited b) - 50·deg c) 0.939 lagging
   d) 5.83·Ω e) 11·hp 87·N·m