

# ECE470 POWER SYSTEMS I

## Homework Set 4

1. A 14 kV, 60 Hz, six-pole Y-connected, **cylindrical-rotor**, synchronous machine has the following ratings: Armature current = 5155 A, Field current = 500 A, Synchronous Reactance =  $1.96 \Omega$ , armature resistance is  $0.04 \Omega$ /phase and the field resistance is  $12.5 \Omega$ . The excitation voltage ( $E_f$ ) at the rated speed is 14.7 kV (line) when the field current is 350 A.
  - a) Determine the MVA rating of the machine.
  - b) Construct the capability curve for rated generator operation.
  - c) Determine the power factor and the load angle for rated conditions.
  - d) Driving Torque for rated conditions if the rotational losses are 6.25 MW .
  - e) Efficiency for rated conditions.
  
2. A single-phase, 60-Hz power line is supported on a horizontal crossarm, its conductors are 2.5 m apart and carrying a current of 100 A. A telephone line is also supported on a horizontal crossarm 1.5 m directly below the power line, and the spacing between the conductors is 1.0 m. Determine (a) the mutual inductance between the power and telephone circuits and (b) the induced voltage per mile in the telephone line.
  
3. The single-phase power line and the telephone line described in Problem 2 are placed in the same horizontal plane. The distance between the nearest conductors of the two lines is 10 m. Determine (a) the mutual inductance between the power and telephone circuits and (b) the induced voltage per mile in the telephone line.
  
4. A three-phase, 60-Hz transmission line has a flat horizontal spacing of 10 m between adjacent conductors. Each phase conductor is 1113-MCM ACSR Finch. Compare the capacitive reactance in  $\Omega$ -mi/phase of this transmission line with that of another transmission line using a bundle of two ACSR 26/7 conductors in each phase having the same total cross-sectional area of aluminum as the single-conductor line and 10 m spacing between bundle centers. The spacing between conductors in the bundle is 25 cm.

5. A three-phase, 60-Hz transmission line is composed of 300-MCM 26/7 ACSR conductors that are equilaterally spaced with 1.5 m between conductor centers. The line is 50 km long, operates at  $55^{\circ}\text{C}$ , and delivers 2.5 MW at 13.8 kV to a load connected to its receiving end. Find the sending-end voltage, current, real power, and reactive power for the following conditions.
- 80% power factor lagging
  - Unity power factor
  - 90% power factor leading
6. A 765 kV overhead transmission line consists of Bluebird ACSR on Guyed-Y towers as shown. The inter-phase spacing is 44' & 38', while the intra-phase conductor spacing is 1' with four conductors/bundle. The line is 400 miles long and operates at  $110^{\circ}\text{C}$ .
- Determine the pi equivalent circuit in terms of;  $R$ ,  $X_L$ ,  $X_C$ .
  - Determine the nominal charging current.

