

**University of Saskatchewan**  
**College of Engineering**  
**EE 342: Power Systems I**  
**Final Examination**  
*Two formula sheets are allowed*

**Instructor: S.O. Faried**  
**Duration: 3 hours**

**December 6, 2008**

1. A 60-Hz, 500kV, 400 km three-phase transposed line is composed of two-conductors per phase with horizontal configuration as shown in Fig. 1. The conductors have an outside diameter of 1.762 inches, resistance of  $0.0288 \Omega/km$  and  $D_s = 0.0588 \text{ ft}$ . Find:

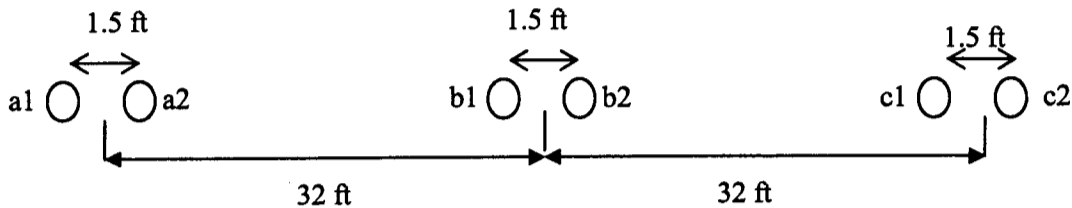


Fig. 1.

- a) The ABCD constants of the line.
  - b) The transmission efficiency if the line delivers 600 MW at 0.9 power factor lagging at 500 kV.
  - c) The surge impedance loading and the wavelength of the line.
  - d) The value of the two identical series capacitor banks (one bank is installed at the sending end and the other bank is installed at the receiving end) per phase required to compensate 60% of the line inductive reactance.
  - e) The ABCD constants of the line after installing the two capacitor banks.
2. Draw the one line reactance diagram for the power system shown in Fig. 2. Select 1000 MVA base and 20 kV base at Generator 1.

$$G_1, 400 \text{ MVA}, 26 \text{ kV}, x = j0.8 \text{ p.u.}, \quad G_2, 600 \text{ MVA}, 13 \text{ kV}, x = j0.8 \text{ p.u.},$$

$$G_3, 500 \text{ MVA}, 18 \text{ kV}, x = j1.0 \text{ p.u.}$$

$$T_1, 400 \text{ MVA}, 26/500 \text{ kV}, x = j0.1 \text{ p.u.}, \quad T_2, 700 \text{ MVA}, 13/500 \text{ kV}, x = j0.1 \text{ p.u.}$$

$$T_3, 600 \text{ MVA}, 18/500 \text{ kV}, x = j0.1 \text{ p.u.}$$

$$T.L_{AB}, x = j50 \Omega, \quad T.L_{BC}, x = j40 \Omega, \quad T.L_{AC}, x = j60 \Omega, \quad S_L, 0.05 + j0.2 \Omega$$

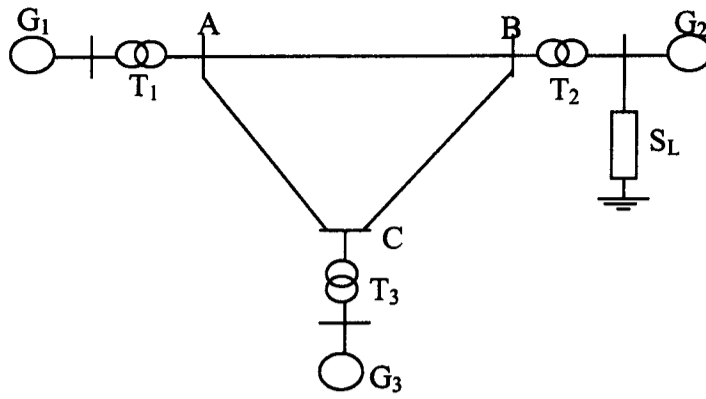


Fig. 2

3. Consider the sample power system shown in Fig.3. All reactances are in per unit. Find the bus impedance matrix  $Z_{bus}$ .

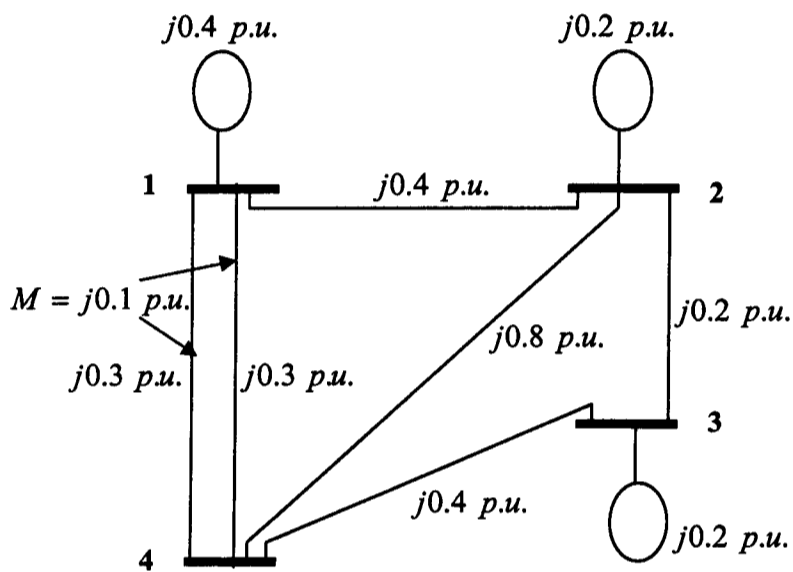


Fig. 3

4. Consider the two-bus system shown in Fig.4. The load  $S_L = 5 + j4$  p.u. power is supplied by the generator via the line. The line is represented by an equivalent  $\pi$  network, the impedances of which are as follows:

$$Z_s = 0.01 + j0.05 \text{ p.u.}, \quad Z_p = -j3 \text{ p.u.}$$

The generator reactance is  $X_g = j1.0 \text{ p.u.}$  The magnitude  $|V_2|$  of the voltage of bus 2 must equal  $1.0 \text{ p.u.}$  Determine:

- (a) The voltage that we must maintain at bus 1 in order to achieve the above objective. Find also the generator internal voltage.
- (b) The required active and reactive generation ( $P_G$  &  $Q_G$ ).

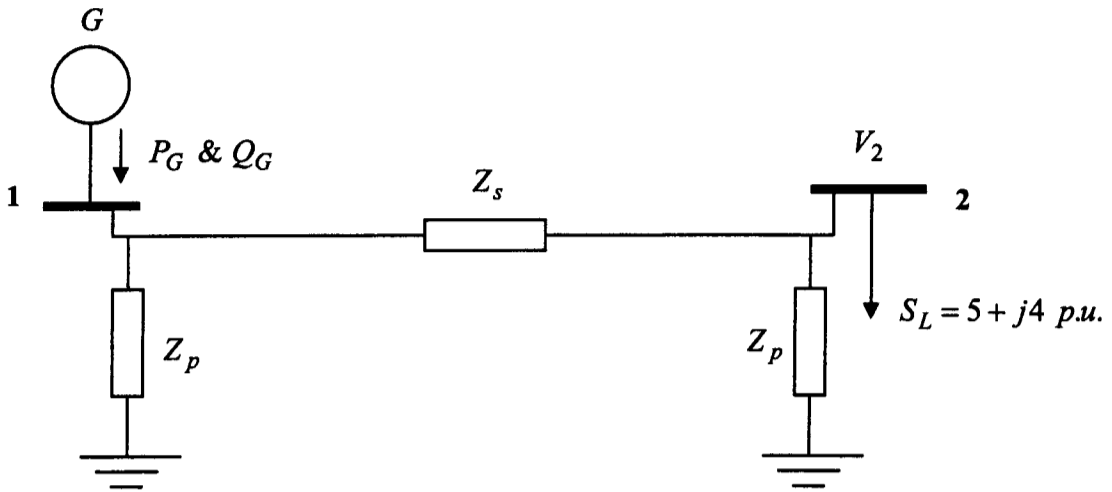


Fig. 4