University of Saskatchewan
College of Engineering

EE 342: Power Systems I
Final Examination
A one formula sheet is allowed

Instructor: S.O. Faried **December 12, 2005**
Duration: 3 hours

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1. Each conductor of the bundled-conductor line shown in Fig.1 is ACSR Bobolink (outside diameter = 1.427 inch, GMR = 0.047 ft). Find the 60-Hz inductive reactance and capacitive susceptance in ohms per km and siemens per km per phase, respectively. The spacing between the conductors of the bundle is 0.3 m.

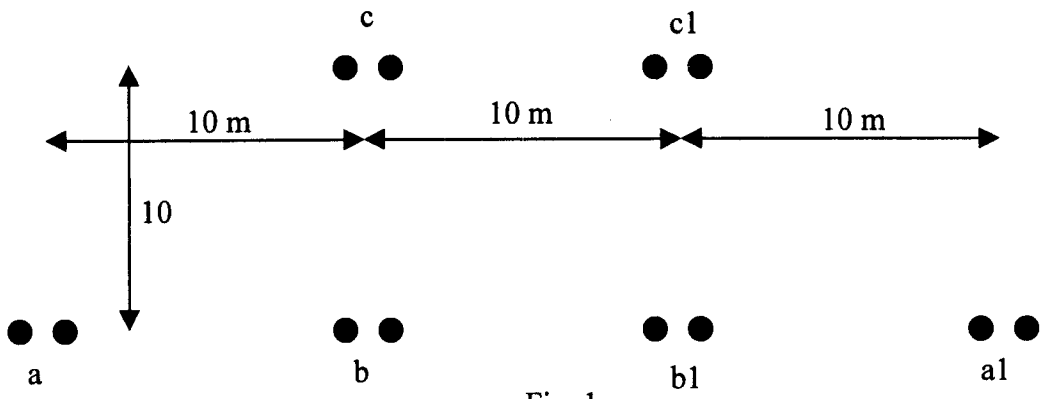

Fig. 1.

2. A three-phase 60-Hz , 765 kV, 500 km transmission line has the following impedance and admittance:

   $z = 0.0165 + j\,0.3306\ \Omega/km, \quad y = j4.674\ \mu S/km$

   (a) What is the surge impedance loading of this line?

   (b) If the line delivers 2000 MW at 765 kV and 0.8 p.f. lagging, find the sending end voltage, the sending end current and the line efficiency.

   (c) For this part ONLY assume that the line resistance and capacitance are to be neglected and the magnitudes of the sending end receiving end voltages are kept constant at 765 kV, find the maximum power transferred on this line.

   (d) With the same assumptions of part (c), find the value of the series capacitor/phase that would double the maximum power transfer on the line.

3. Show that the GMR of a hollow conductor of inner radius r and outer radius R is given by $Re^{-K\mu_c}$, where μ_c is the relative permeability of the conductor material and K is constant that can be expressed as:

$$K = \frac{\left(AR^4\right) - R^2r^2 + \left(Br^4\right) + r^4 \ln\frac{R}{r}}{\left(R^2 - r^2\right)^2}$$

   Find the numerical values of A and B.

4. Draw the one line reactance diagram for the power system shown in Fig. 2. Select 1000 MVA base and 20 kV base at Generator 3.

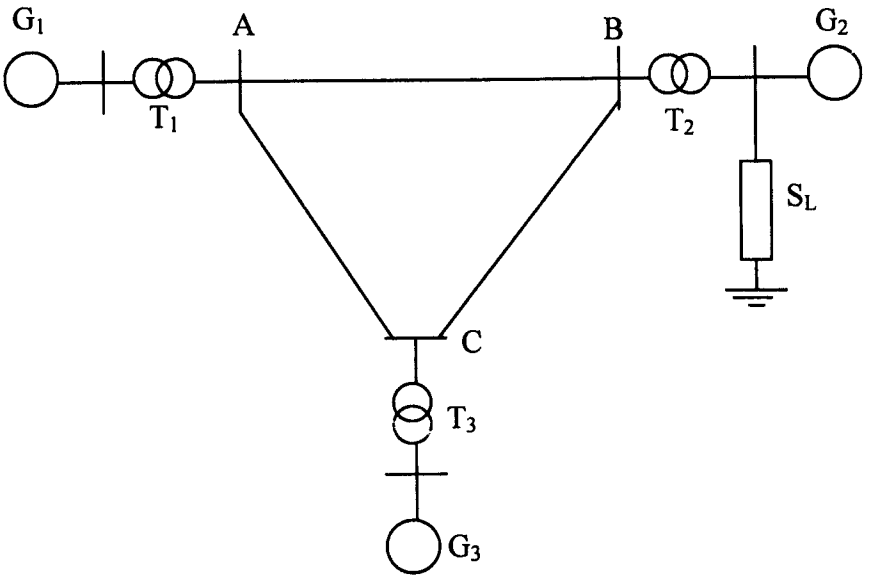

Fig. 2

G_1, 400 MVA, 26 kV, $x = 0.8$ $p.u.$, G_2, 600 MVA, 13 kV, $x = 0.8$ $p.u.$
G_3, 500 MVA, 18 kV, $x = 1.0$ $p.u.$, T_1, 400 MVA, 26/500 kV, $x = 0.1$ $p.u.$
T_2, 700 MVA, 13/500 kV, $x = 0.1$ $p.u.$, T_3, 600 MVA, 18/500 kV, $x = 0.1$ $p.u.$
$T.L_{AB}$, $x = j50\ \Omega$, $T.L_{BC}$, $x = j40\ \Omega$, $T.L_{AC}$, $x = j60\ \Omega$, $S_L = 0.05 + j0.2\ \Omega$

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

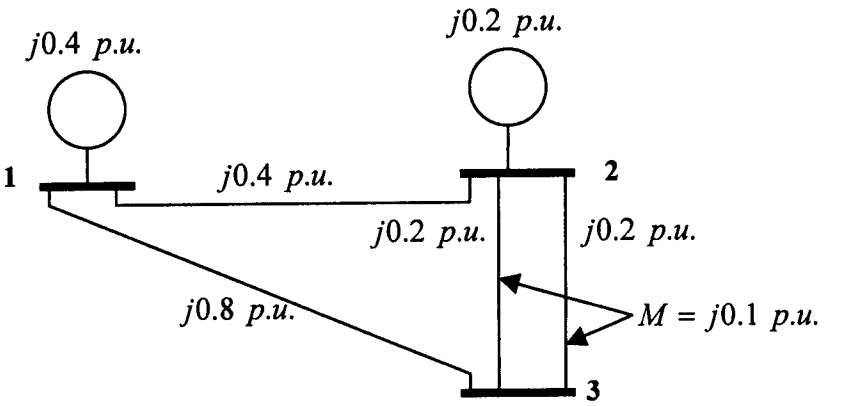

Fig. 3