1. Consider two ideal voltage sources connected by a line of impedance Z= jX Ω, as shown in Fig.1. Let the phasor voltage be $V_1 = |V_1|\angle\delta_1$ and $V_2 = |V_2|\angle\delta_2$.

   (a) Please derive the equations for P_{12} (real power from bus 1 to bus 2) and Q_{12} (reactive power from bus 1 to bus2) (20%)

   (b) whether Q_{12} is equal to Q_{21}? Why? (5%)

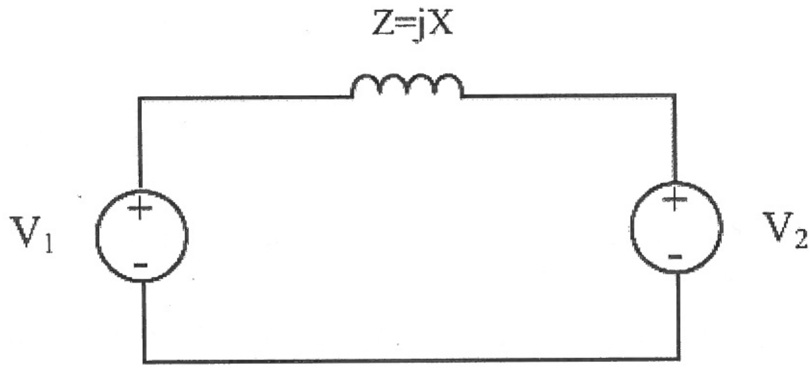

Fig. 1

2. (a) Please classify various types of buses in a power system for power flow analyses.(5%)

   (b)Please obtain the bus admittance matrix for Fig.2 (10%)

   (c)Please derive the power flow equations for P_2, P_3, and Q_3 for Fig.2. (15%)

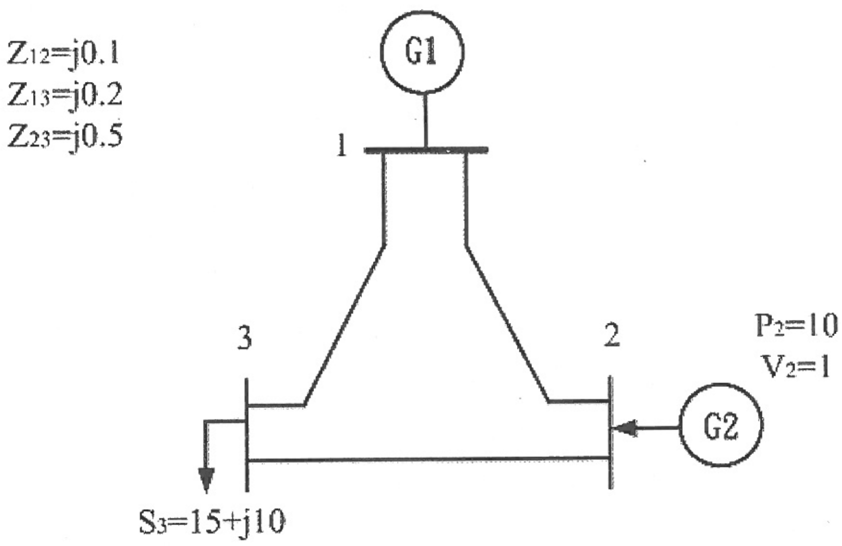

Fig. 2

3. The system shown in Fig. 3 is initially on no load with generators operating at their rated voltage with their emfs in phase. The rating of the generators and the transformers and their respective percent reactances are marked on Fig.3. All resistances are neglected. The line impedance is $j160$. A three-phase balanced fault occurs at the receiving end of the transmission line. Determine the short-circuit current and the short-circuit MVA. (20%)

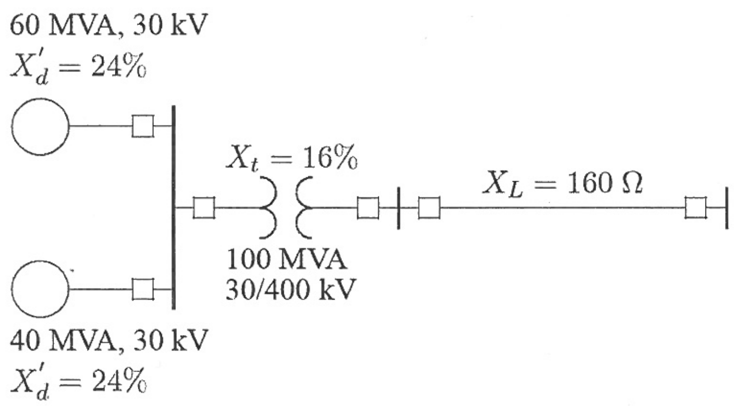

Fig. 3

4. Please answer the following questions: (25%)
   (a) What is the inertia constant? What is the effect of inertia constant on the grid?
   (b)What is the spinning reserve? What is the effect of spinning reserve on the unit commitment?
   (c) What is the reactive power compensation? Why the reactive power compensation is required in some cases?
   (d) What is the critical clearing time?
   (e) Please introduce briefly several technologies on smart grids