

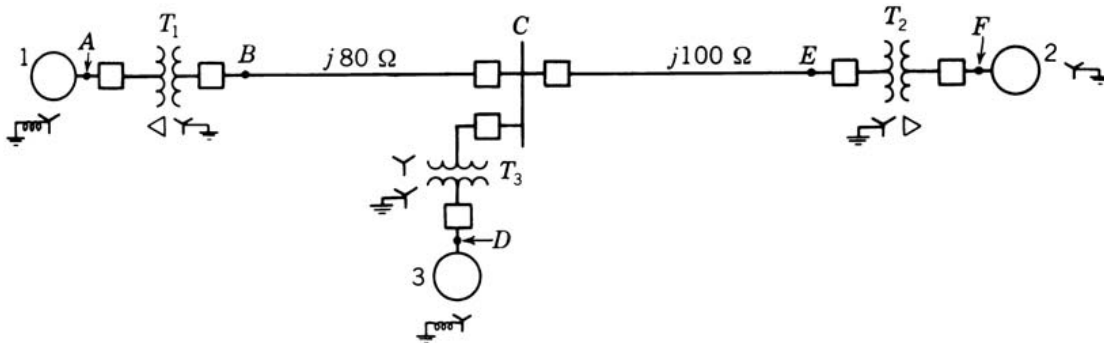
### Problem Set #3: Synchronous machines and short-circuit calculations

#### 3-1

The single-line diagram of an unloaded power system is shown in Fig. 3.22. Reactances of the two sections of the transmission line are shown on the diagram. The generators and transformers are rated as follows:

Generator 1:	20 MVA, 13.8 kV, $X''_d = 0.20$ per unit
Generator 2:	30 MVA, 18 kV, $X''_d = 0.20$ per unit
Generator 3:	30 MVA, 20 kV, $X''_d = 0.20$ per unit
Transformer $T_1$ :	25 MVA, 220Y/13.8 $\Delta$ kV, $X = 10\%$
Transformer $T_2$ :	single-phase units, each rated 10 MVA, 127/18 kV, $X = 10\%$
Transformer $T_3$ :	35 MVA, 220Y/22Y kV, $X = 10\%$

- Draw the impedance diagram with all reactances marked in per unit and with letters to indicate points corresponding to the single-line diagram. Choose a base of 50 MVA, 13.8 kV in the circuit of generator 1.
- Suppose that the system is unloaded and that the voltage throughout the system is 1.0 per unit on bases chosen in part *a*. If a three-phase short circuit occurs from bus *C* to ground, find the phasor value of the short-circuit current (in amperes) if each generator is represented by its subtransient reactance.
- Find the megavoltamperes supplied by each generator under the conditions of part (b).



One-line diagram for Prob. 3.12.

3-2

The ratings of the generators, motors, and transformers of Fig. 3.23 are

Generator 1:	20 MVA, 18 kV, $X_d'' = 20\%$
Generator 2:	20 MVA, 18 kV, $X_d'' = 20\%$
Synchronous motor 3:	30 MVA, 13.8 kV, $X_d'' = 20\%$
Three-phase Y-Y transformers:	20 MVA, 138Y/20Y kV, $X = 10\%$
Three-phase Y- $\Delta$ transformers:	15 MVA, 138Y/13.8 $\Delta$ kV, $X = 10\%$

- (a) Draw the impedance diagram for the power system. Mark impedances in per unit. Neglect resistance and use a base of 50 MVA, 138 kV in the 40- $\Omega$  line.
- (b) Suppose that the system is unloaded and that the voltage throughout the system is 1.0 per unit on bases chosen in part (a). If a three-phase short circuit occurs from bus C to ground, find the phasor value of the short-circuit current (in amperes) if each generator is represented by its subtransient reactance.
- (c) Find the megavoltamperes supplied by each synchronous machine under the conditions of part (b).

