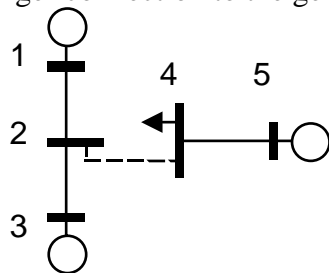# ELG4125: Electric Power Transmission, Distribution, and Utilization

Quiz 2

1. Short-circuit capacity and interconnection

Interconnecting systems has effect on both frequency control and voltage control. When a load center grows, for example because a city is expanding, it is necessary to create a stronger connection to the generating area or areas.

p.u. impedances @ 100MVA

Line 1-2: j0.1   G1 X_1: 0.15

Line 2-3: j0.2   G3 X_1: 0.1

Line 4-5: j0.15   G5 X_1: 0.25

a)   The system to the right is considered weak at bus 4 (connected only to bus 5) as voltage is often outside the required range 1 ± 0.05 p.u. Determine the short-circuit capacity in MVA at the bus assuming nominal no-load voltage 1 p.u.

b)   Determine the p.u. voltage magnitude at bus 4 when a load drawing a 1 p.u. current with power factor 1 is connected there. Assume no other loads, no-load voltage 1 p.u. and that load current does not depend on voltage.

c)   To improve the situation buses 2 and 4 are connected by a line with series impedance j0.1 p.u. as indicated by the dashed line. Repeat a) for the interconnected system.

d)   Repeat b) for the interconnected system. Voltages at G1 and G3 are 1 p.u.

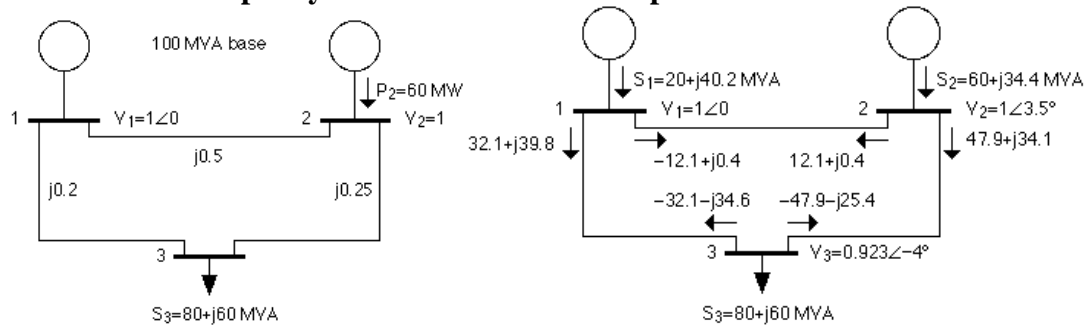## 2. Short-circuit capacity and reactive shunt compensation

Figure 1 Three-bus power system used for load flow calculations (left) and load flow solution (right). Voltages and line impedances are in per unit.

a)   Determine the short-circuit capacity in MVA at bus 3 of the system in Figure 1. To simplify you can neglect the load at this bus.

b)   A shunt capacitor of 50 Mvar is added to bus 3 where the load is 80+j60 MVA. This will change the voltage from the value shown in Figure 1. The voltage sensitivity to reactive power ($\partial V/\partial Q$) gives an estimate of how much the voltage will change when the reactive power load is changed. This sensitivity can be approximated:

$$\frac{\partial V}{\partial Q} = \left(\frac{\partial Q}{\partial V}\right)^{-1} \approx -\frac{1}{S_{SC}(p.u.)}$$

Estimate the voltage at bus 3 with the 50 Mvar capacitor added using this expression.