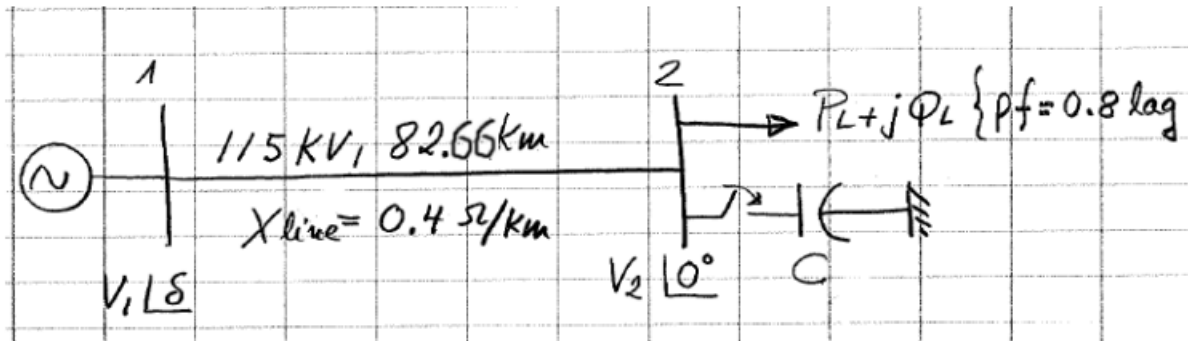


## EXERCISE No. 5

Tutorial Date: Tuesday 16th October  
**POWER CIRCLE DIAGRAM**

Consider the following power transmission system



System Base: 100 MVA, 115 kV at bus 1. Bus 1 is voltage regulated.

All questions are to be solved using the power circle diagram built in per unit quantities. The diagram is to be built for the the receiving-end bus 2.

1. With  $V_2 = 1.0$  pu and load's  $pf = 1.0$ , determine the maximum active power that can be transmitted between 1 and 2 without exceeding a transmission angle of  $\delta = 30^\circ$ , and the voltage  $V_1$  required for this condition. Verify your answer using the power transfer formula:  

$$P_2 = \frac{V_1 \cdot V_2}{X} \sin \delta$$
2. Assume that  $P_L$  has the value calculated in 1) for maximum real power transmission, but the  $pf = 0.8$  lagging. Assume also that the voltage at the sending end is to be limited to  $V_1 = 1.05$  pu. Determine the reactive power  $Q_c$  (in MVAR) that needs to be provided by the bank of capacitors shown in the diagram to achieve the indicated operation. Calculate the value of the capacitors  $C$  in  $\mu F$  assuming they are connected in star.
3. Suppose that in order to save money, only half the  $Q_c$  calculated in 2) is installed. What would be the needed sending-end voltage  $V_1$  and  $\delta$  to maintain  $V_2 = 1.0$ ?