

Analysis of electrical power and energy systems

Practical session 6

18 November 2021

1 Voltage instability in power systems

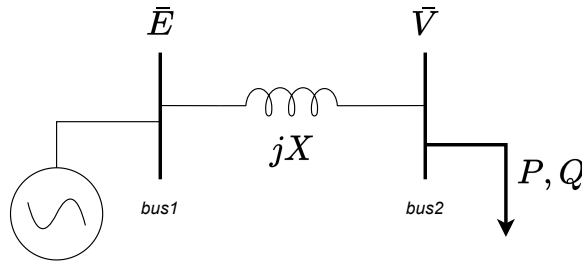


Figure 1: Representation of a lossless transmission line.

1. Consider the transmission line shown in Figure 1. A load consuming an active power P and a reactive power Q is connected to *bus2*. The voltage phasor of *bus2* is $\bar{V} = V\angle\delta$. A generator is connected to *bus1* and control the voltage at that bus. The voltage phasor of *bus1* is $\bar{E} = E\angle 0$. The transmission line is assumed to be lossless and the reactive power limits of the generator are not considered here. Based on those assumptions, derive the mathematical relationship between the power P consumed by the load and the voltage magnitude at *bus2*: V .
2. Derive the mathematical expression of the maximum power transmissible through the line. What are the important parameters to consider if you want to transmit more power through the line?

2 Solutions

Link to the Python Notebook shown during the session: Python Notebook TP6

1. $V = \sqrt{-XQ + \frac{E^2}{2}} \pm \sqrt{\frac{E^4}{4} - X^2P^2 - E^2XQ}$ with $Q = P \tan \phi$
2. $P_{max} = \frac{E^2}{2X} \left(\frac{1 - \sin(\phi)}{\cos(\phi)} \right)$