

# Analysis of electrical power and energy systems

## Practical session 7

17 November 2022

### 1 Transient stability

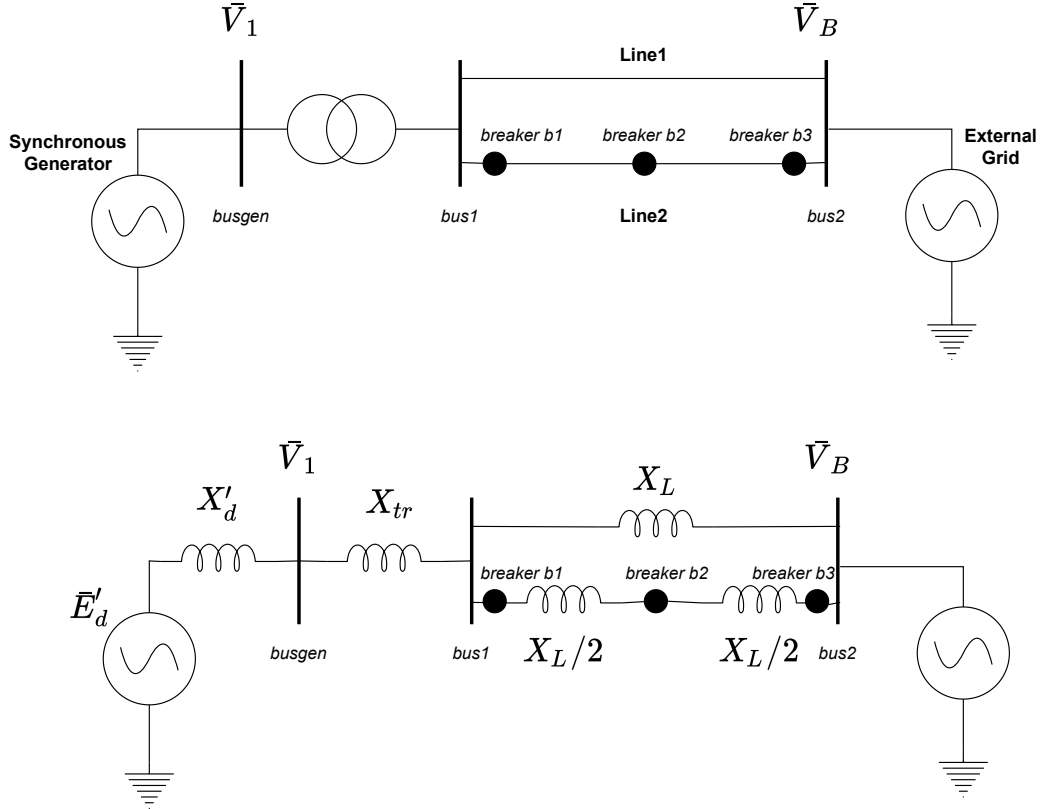


Figure 1: One-Machine-Infinite-Bus system.

1. Consider the one-machine-infinite-bus system shown in Figure 1. A synchronous generator converts a mechanical power  $P_m$  into an electrical power  $P_e$  (without conversion losses) which is transferred to the network through a step-up transformer and two parallel lines with same impedances. The electrical losses are not considered in this system therefore, the step-up transformer can be represented by an equivalent reactance  $X_{tr}$ . The following data are given :

$$X_L = 1pu, X'_d = 0.3pu, X_{tr} = 0.5pu, \bar{V}_B = 1\angle 0^\circ.$$

$$\text{Initial values : } \bar{E}'_d = E'_d \angle \delta, \bar{V}_1 = 1\angle 30^\circ$$

- (a) What is the initial active power transferred  $P_e$ ? Calculate the maximal power transmissible  $\hat{P}_e$ .
- (b) Consider a three-phase short-circuit close to breaker  $b_2$  cleared by the tripping of line 2. Plot the  $P - \delta$  curves for the three situations: before short-circuit, during

short-circuit and after short-circuit. Assume that the voltage magnitude  $E'_d$  is kept constant as well as voltage phasor  $\bar{V}_B$ .

- (c) Calculate the critical fault clearing angle  $\delta_{cr}$  using the equal area criterion.
- (d) What is the impact on the critical fault clearing angle if the short-circuit occurs close to breaker  $b_1$ ?

## 2 Solutions

Link to the Python notebook shown during the session: Python Notebook TP7

1. (a)  $P_e = 0.5$  pu,  $\hat{P}_e = 0.808$  pu

(b) See python notebook

(c)  $\delta_{cr} = 49.37^\circ$

(d)  $\delta_{cr} = 43.74^\circ$