Department of Electrical and Computer Engineering

Transmission Line Models
(Lecture 3-Long Transmission Lines)

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Outline

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- Lecture 3:
  - Review of lectures 1 and 2.
  - Peer assessment of homework on medium lines
  - Long Transmission Line Model
  - In-class Example (Long Line)
  - Debriefing

Review of previous lectures

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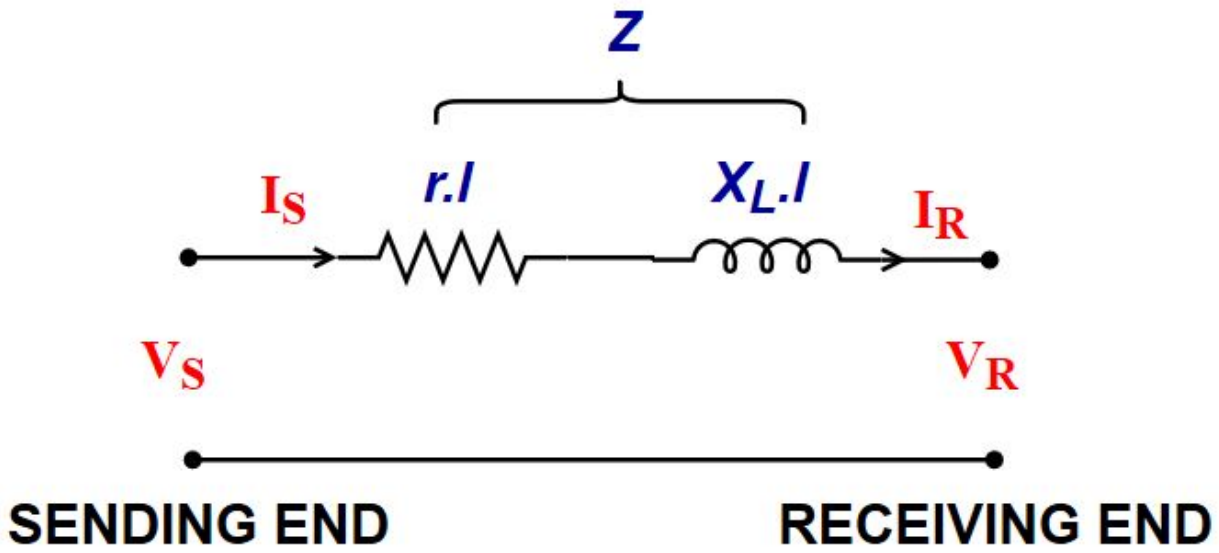
Quick Questions

Quick question 11:

(a) Name the line parameters usually considered when modeling short lines? Why are other parameters neglected when modeling short lines?

Answer:

(a) The parameters considered are resistance and Inductance. Capacitance is neglected because as the short lines are usually less than 80 km, the line charging current is small and thus can be neglected. Moreover, conductance is neglected because the leakage current is small.



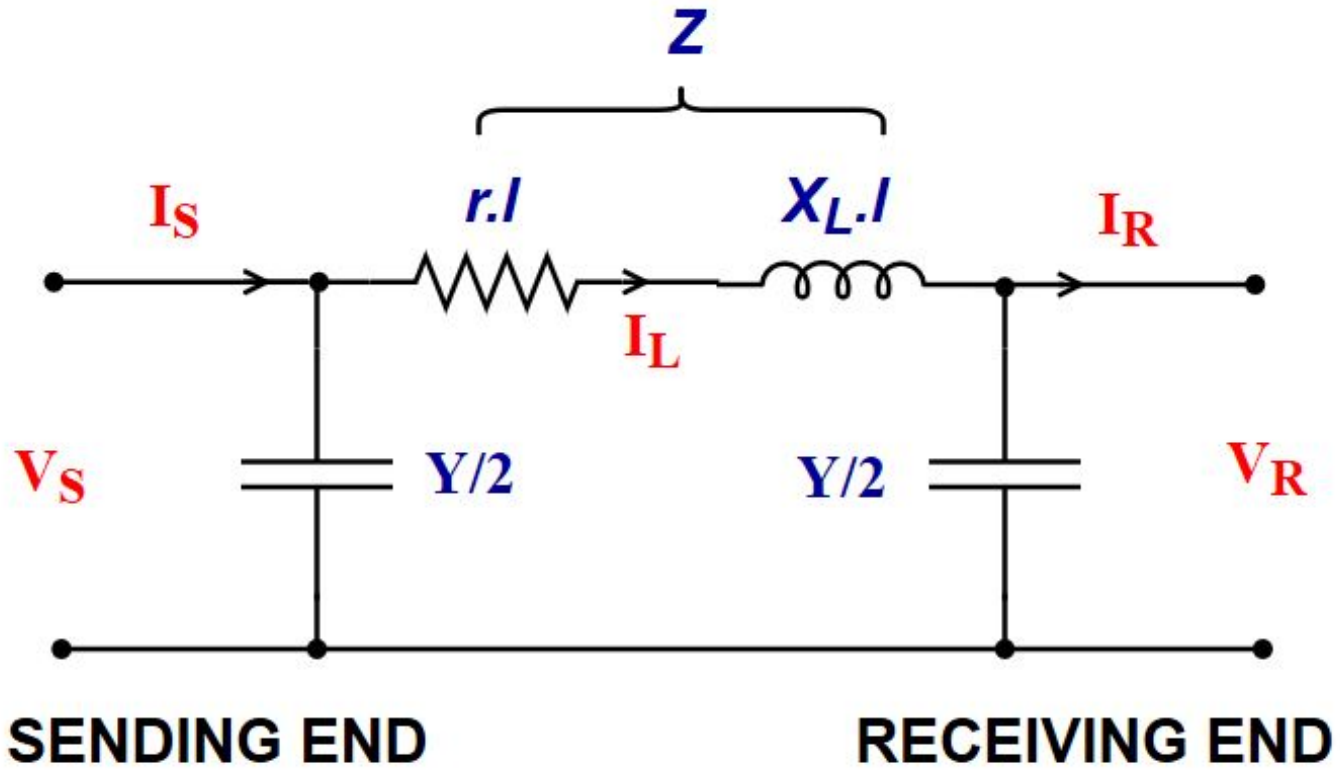
The Short transmission line model

Quick question 12:

(a) Name the line parameters used in modeling medium-length transmission lines? Are these parameters considered lumped or distributed?

Answer:

(a) The parameters considered for medium-length lines are resistance, inductance and capacitance. The parameters are considered lumped.



The medium transmission line model

Quick question 13:

(a) What happens to the percent voltage regulation (V.R.) when the load power factor is lagging?

(b) What happens to the percent V.R. when the load power factor is leading?

(c) Do electric utility operators (e.g. AESO, ENMAX) prefer a smaller or larger value for the percent voltage regulation?

Answer:

(a) When the load power factor is lagging, the percent V.R. will be larger in value compared to the case of unity power factor

(b) When the load power factor is leading, the percent V.R. will be smaller in value compared to the case of unity power factor

(c) Electric utility operators (e.g. ENMAX) prefer small percent V.R. (which is obtained with high power factor or leading power factor load) as it entails low voltage drop or in other words, low power loss occurs along the transmission line. As a result of the benefit associated with having small percent V.R., utility operators always incentivize electricity consumers to replace their low power factor equipment with a high-power factor equipment or install capacitors across their equipment to improve its power factor.

Peer assessment of homework on medium lines

- Exchange your homework with your peer
- Comment on the method adopted by your peer to obtain the homework solutions: Is it right or wrong?; Is anything missing?; What is the right step to take to remedy any error found?

In-Class Example (Lecture 2)

1. The sending-end voltage, current, and power factor of a three-phase transmission line spanning from Red Deer to Calgary are found to be 260 kV, 300 A, and 0.9 lagging, respectively. The *ABCD* constants are:

$$A = D = 0.8904\angle 1.34^{o}$$

$$B = 186.82\angle 79.45^{o}\ \Omega$$

$$C = 1.131 \times 10^{-3}\angle 90.41^{o}\ \text{S}$$

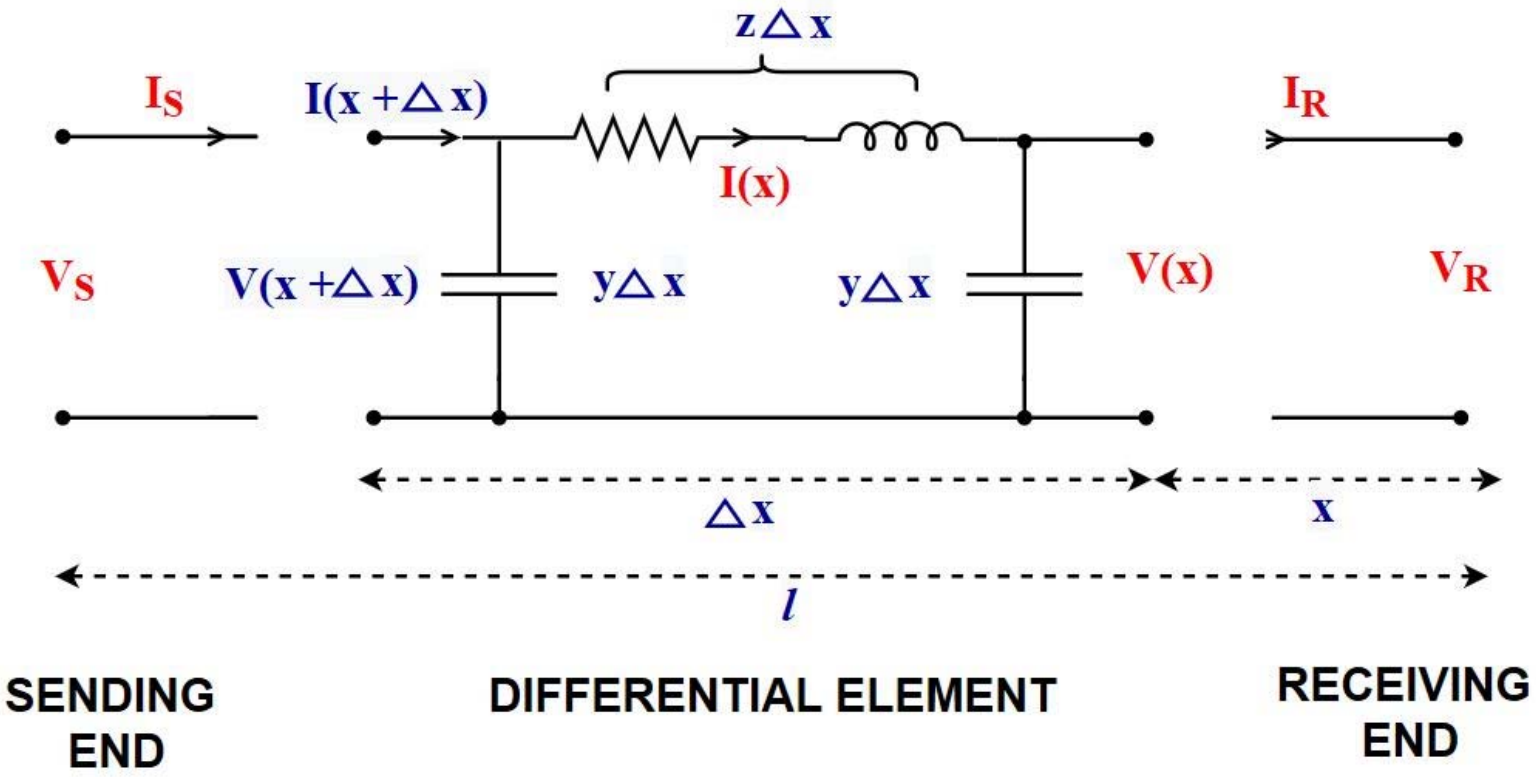
Find:

(i) The corresponding receiving-end phase voltage and current

(ii) The receiving-end power factor

2. Find the percent voltage regulation of the medium line described in (1)

THE LONG TRANSMISSION LINE MODEL



Please see the ABCD-form based equations of a long line and its equivalent pi model in the notes

DID YOU KNOW?

The long transmission line model was developed in 1880's by Oliver Heaviside to demonstrate the behavior of electromagnetic waves travelling through a wire.

So there is a connection between the transmission line models developed in electromagnetic waves and applications course (ENEL 476) and the ones being developed in this course. The only difference is that in this course, the frequency of the current or waves is very low (about 60 Hz) whereas in ENEL 476, it is in the order of MHz.

The equations obtained from the long transmission line model are also called telegrapher's equations because they were mainly used for telecom applications when they were developed

In-Class Example (Lecture 3)

3. A single-circuit 60 Hz transmission line that is utilized to import power into Alberta from British Columbia (BC) is 350 km long. The conductors of the transmission line have an impedance of $z = 0.524\angle 79.04^{o}\ \Omega/km$, and a shunt admittance of $y = 3.172\times10^{-6}\angle 90^{o}$ S/km. If the load at the Alberta end is 130 MW at 220 kV with unity power factor, calculate the voltage, current, and real power at the sending end (British Columbia end) and the voltage regulation of the line.

4. Use the ABCD constants calculated from question (3) to generate the equivalent pi-model of the Alberta-BC 220 kV transmission line.

Final Questions ??

- Feel free to send an email to me (udoka.nwaneto1@ucalgary.ca) if you have any questions
- Please, also fill in the survey (about your learning experience) that would be sent out in the next couple of days. I appreciate the feedback you have been giving me since I started my practicum. They have been super helpful.
- Do have a wonderful weekend