

EE303 — Energy Systems and Power Electronics

Lecture 19. Electric power transmission

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Electrical & Computer Engineering

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Today's objectives

- **DESCRIBE** structure of high-voltage transmission lines
- **IDENTIFY** electrical parameters of transmission lines
- **PRESENT** lumped-parameter equivalent circuits of transmission lines
- **PRESENT** fundamental concepts of power flow through transmission lines

Copper vs. aluminum

COPPER:

- + has a higher conductivity than aluminum: 59.6 vs. 37.8 MS/m
- + is more ductile (can be drawn out into a thin wire)
- + has relatively high tensile strength (the greatest stress a substance can bear along its length without tearing apart): 55,000 psi vs. 25,000 psi
- + can be easily soldered
- is more expensive: 3\$/lb vs. 0.9\$/lb. (LME, 10/26/09)
- is heavier than aluminum: 8.94 vs. 2.70 g/cm³

ALUMINUM:

- + reduces corona effect
- + is lighter, so it permits longer spans

Commercial products

- <http://www.pdic.com/Products/>
- <http://www.cable.alcan.com/alcancable/en-US/Products/United+States/>
- <http://www.generalcable.com/GeneralCable/en-US/Products/ElectricUtilityCables/Catalog/ProEleCatalog.htm>
- <http://www.otds.co.uk/overhead-cables.php>

Example T1.1, p. 62

Example

An ACSR 100-mile 230-kV transmission line has a resistance of $0.1 \Omega/\text{mile}/\text{phase}$ and an inductive reactance of $0.777 \Omega/\text{mile}/\text{phase}$. The voltage at the sending end is 231 kV and the current through the line is 125 A, lagging the sending end voltage by 20 degrees.

- Compute the receiving end voltage, and the voltage drop across the line caused by the resistance and that caused by the reactance.
- Compute the real power flowing into the line, the real losses, and the real power flowing out of the line.
- Compute the reactive power flowing into the line, the reactive losses, and the reactive power flowing out of the line.

Example

Example

For the previous transmission line, assume that the shunt reactance is $0.2 \text{ M}\Omega \cdot \text{mi}$.

- What is the shunt admittance per mile, and total shunt admittance of the line?
- Draw the line's π -equivalent circuit.
- If the line's receiving end is open-circuited, compute the receiving end voltage.
- Compute the currents in the π -equivalent circuit branches.

Reading material

The material we covered today corresponds to:

- Module T1, pp. 59–78 of the class notes