**Reading:** Chapter 5 from textbook.

**In-class quiz:** Thursday, September 27, 2018

**Problem 1.** A 500-km, 500-kV, 60-Hz uncompensated three-phase line has a positive-sequence series impedance $\bar{z} = 0.03 + j0.35 \, \Omega/km$ and a positive-sequence shunt admittance $\bar{y} = j4.4 \times 10^{-6} \, S/km$. Calculate:

(a) $Z_c$

(b) $(\gamma d)$

(c) The exact ABCD parameters for this line.

**Problem 2.** A 320-km, 500-kV, 60-Hz three-phase uncompensated line has a positive-sequence series reactance $x=0.34 \, \Omega/km$ and a positive-sequence shunt admittance $y=4.5 \times 10^{-6} \, S/km$. Neglecting losses, calculate:

(a) Its characteristic impedance $Z_c$.

(b) The value of $\gamma d$.

(c) The exact ABCD parameters for this line.

(d) The surge impedance loading in MW.

**Problem 3.** The per-phase impedance of a short three-phase transmission line is $0.5 \angle 53.15^\circ \, \Omega$. The three-phase load at the receiving end is 900 kW at 0.8 p.f. lagging. If the line-to-line sending-end voltage is 3.3 kV, determine:

(a) The receiving-end line-to-line voltage in kV.

(b) The line current.

(c) The phasor diagram with the line current $I$, as reference.

**Problem 4.** To maintain a safe “margin” of stability, system designers have decided that the power angle $\theta_{12} := \theta_1 - \theta_2$, where $\theta_1$ is the phase angle of the sending-end voltage and $\theta_2$ is the phase angle of the receiving-end voltage, cannot be greater that $45^\circ$. We wish to transmit 500 MW through a 300-mile line and need to pick a transmission-line voltage level. Consider 138-, 345-, and 765-kV lines. Which voltage level(s) would be suitable? As a first approximation, assume that the voltage magnitudes on sending and receiving ends are equal, i.e., $V_1 = V_2$ and the lines are loseless, i.e., $\gamma = j\beta$, with $\beta = 0.002 \, \text{rad/mi}$.

**Problem 5.** Given a transmission line described by a total series impedance $Z = \bar{z}d = 20 + j80 \, \Omega$ and a total shunt admittance $Y = \bar{y}d = j5 \times 10^{-4} \, \Omega$.

(a) Find its characteristic impedance $Z_c$, $\gamma d$, $e^{\gamma d}$, sinh $\gamma d$, and cosh $\gamma d$.

(b) Suppose that the line is terminated in its characteristic impedance $Z_c$. Find the efficiency of the transmission line in this case, i.e., find $\eta = -P_{21}/P_{12}$, where $P_{21}$ is the active power flowing from the receiving end to the sending end of the line, and $P_{12}$ is the active power flowing from the sending end to the receiving end of the line.