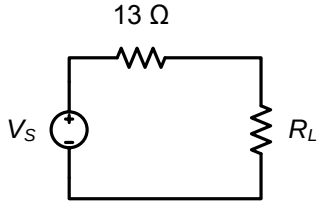
Homework Assignment #2 Due: Monday, Jan. 30

Chapter 2

Problems: 4, 7, 8, 10, 15, 17, 18, 23, 25, 27, 39, 40, 45
Points: (4), (4), (3), (4), (5), (4), (4), (3), (3), (4), (3), (4), (4)

HD.1 (10 points)
In this problem, we consider some issues associated with power loss (as heat) in high-voltage transmission lines. In particular, we consider the transmission of power from Page, Arizona (located near the Navajo Generating Station and the Glen Canyon Dam), to the Phoenix metropolitan area. This is a distance of about 260 miles. For this problem, we assume that the high voltage transmission lines have a resistance of 0.05 Ω/mile; hence, the resistance in the 260-mile transmission line is 13 Ω. We model this system using the following circuit:



The voltage source V_S models the power generating facilities. The 13-Ω resistor models the power transmission lines. R_L models the load (users in the Phoenix metro area). Note that by controlling the amount of power dissipated by the load and by using transformers to step voltages up or down (which we will not discuss in detail in this class), the value of R_L used to model the load can be varied. In this problem, assume that you can choose R_L to be whatever is necessary to solve the problem.

(*a*) Suppose first that V_S = 400 kV, and that the source should supply 800 MW to the circuit.
- (i) Find the value of R_L so that the power supplied by the source is 800 MW.
- (ii) For this value of R_L, what is the power dissipated by the transmission line (*i.e.*, the 13 Ω resistor)?
- (iii) What percentage of the power supplied by the source is dissipated by the transmission line?

(*b*) Now consider a lower source voltage of V_S = 200 kV.
- (i) Find the value of R_L so that the power supplied by the source is 800 MW.
- (ii) For this value of R_L, what is the power dissipated by the transmission line?
- (iii) What percentage of the power supplied by the source is dissipated by the transmission line? How does this compare to a source voltage of 400 kV?

(*c*) Using the results of parts (*a*) and (*b*), determine which source voltage would transmit power most efficiently: 1 kV or 100 MV.