Solve this homework using Excel. Make your time stepsize equal to the travel time down the tower.

Problem. A 35kA, 1 x 20 (i.e., 35kA peak, rise time = 1μs, fall time = 20μs) lighting bolt hits the top of a 345kV steel transmission tower.

Part 1: Ignoring the bounce back from neighboring towers (100's of meters away), and assuming that the velocity of propagation is the speed of light (i.e., 300m per μs), determine and plot

1. Voltage V_{top} at the tower top
2. Voltage V_{bottom} at the tower bottom
3. Voltage $V_{crossarm}$ at the crossarm (for this problem, it is adequate to approximate crossarm voltage using linear voltage division with distance as follows:

$$V_{crossarm} = V_{bottom} + \frac{20}{30}\left(V_{top} - V_{bottom}\right)$$

4. Voltage across the insulator string (worst case, i.e., phase voltage wrt ground at negative peak)

Assume that 30% of the voltage on the ground wire is instantly induced on the phase wire, and that this induced voltage adds to the existing 60Hz phase-to-ground voltage (i.e., voltage coupling factor = 0.3)

Part 2: Determine and plot the 1m step potential, and the corresponding shock energy, starting at 1 - 2m from the tower, then in 1m increments up to 10-11 m from the tower. When determining the shock energy, assume that the person has body resistance 1kΩ, and that each shoe also has resistance 1kΩ.