## ECEN 616 Fall 2022 Example 8

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A 15-km, single-phase transmission line is open on one end, and on the other end is terminated by a resistor. On the open end, a current pulse is injected, modeled as a double exponential with current $i\_{pulse}\left(t\right)=I\_{max}⋅\left(e^{-αt}-e^{-βt}\right)$, where $I\_{max}=10.7 kA$, $α=70000\frac{1}{s}$, and $β=4755000\frac{1}{s}$ (this is a 0.5 $μs$ characteristic lightning impulse). The line uses earth return and consists of a single conductor 1cm in diameter, 10m above the ground. Ignore sag and skin effect. In each of the following scenarios, calculate the maximum voltage on each end of the line:

a) Assuming a lossless earth and lossless transmission line, with a terminating impedance of 100 $Ω$. Use the constant parameter (lossless Bergeron) line model evaluated at 60 Hz. Use EMTP to get the line constants, then solve the circuit both manually (using the programming environment of your choice) and in EMTP.

b) Same as (a) but with a terminating impedance of 500 $Ω$.

c) Assume the conductor has a resistance of 0.1 $Ω/km$ and the earth has a resistivity of 3000 $Ω-m$. Use a terminating impedance of 100 $Ω$. Again, use EMTP to get the line constants, with a constant parameter line model evaluated at 60 Hz. Use the Bergeron assumption, where the total resistance is lumped at the beginning, middle, and end of the line.

d) Same as (c) but with a terminating impedance of 500 $Ω$.

e) Same as (c) but evaluate the line model at 100 kHz.

f) Same as (e) but with a terminating impedance of 500 $Ω$.