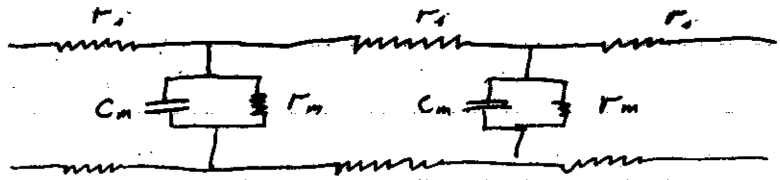

c_m	capacitance / length	$\mu F/cm$	C_m	$\mu F/cm^2$	
r_i	internal longitudinal res	Ω/cm	R_i	$\Omega\ cm$	resistivity
r_m	resistance of unit length	$\Omega\ cm$	R_m	$\Omega\ cm^2$	resistance of area

Loss-less core, Ohm's law $\Delta V = r_i \Delta X\, i_{long}$

derivative $\frac{dV}{dx} = r_i\, i_{long}$

take derivative $\frac{\partial^2 V}{\partial x^2} = r_i \frac{\partial i_{long}}{\partial x} = r_i\, i_m$

loss thru memb c + r $\frac{\Delta i_{long}}{\Delta x} = \frac{\partial i_{long}}{\partial x} = i_m = c_m \frac{\partial V}{\partial t} + \frac{V}{r_m}$

substitute 4 into 3 $\frac{\partial^2 V}{\partial x^2} = V \frac{r_i}{r_m} + r_i c_m \frac{\partial V}{\partial t}$

rearrange $V = \frac{r_m}{r_i} \frac{\partial^2 V}{\partial x^2} - r_m c_m \frac{\partial V}{\partial t}$

(w outside resistor) or $(r_o + r_i)$

solve holding $t \to \infty$ $V_x = V_o e^{-x/\lambda}$ $\lambda = \sqrt{\frac{r_m}{r_o + r_i}}$

(space constant)

solve for $X = 0$ $V_t = V_o (1 - e^{-t/\tau})$ $\tau = R_m C_m = r_m c_m$

(time constant)

change resistance units $\lambda = \sqrt{\frac{r_m}{r_i}} = \sqrt{\frac{R_m / 2\pi a}{R_i / \pi a^2}} = \sqrt{\frac{a\, R_m}{2 R_i}}$ a = radius

space constant varies w/ $\sqrt{\text{radius}}$

change units $\tau = r_m c_m = (R_m / 2\pi a)(2\pi a\, C_m) = R_m C_m$

time constant indep of radius