

Electromagnetic Fields – Tutorial 02 and Assignment 02

Transmission Lines Fundamentals

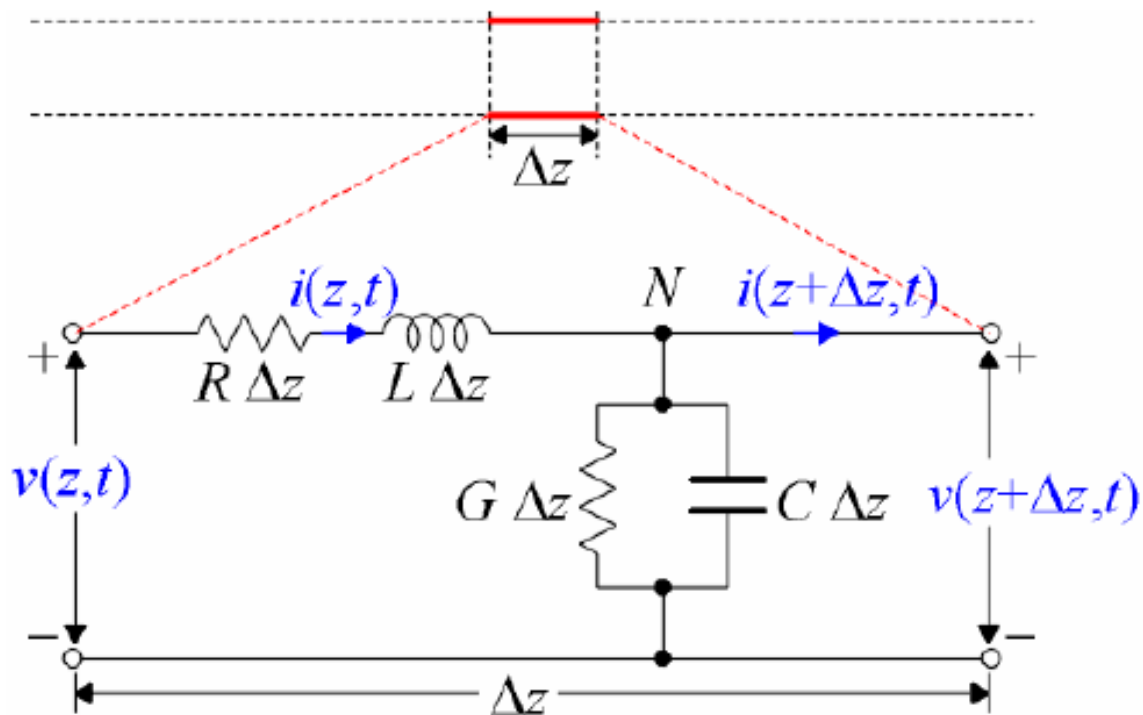
#	Student ID	Student Name	Grade (10)
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١. يتم تسليم التمرين محلولا في خلال أسبوع من تاريخ التمرين، و يتم حذف درجتين من التمرين عن كل أسبوع تأخير
٢. يتم التسليم لمعيد المقرر مباشرة
٣. تتم أجابه التمرين في نفس ورق الأسئلة

Q For a lossless transmission line we drives the following equation

1



Equivalent circuit of a real transmission line.

$$\frac{\partial}{\partial z} v(z,t) = -L \frac{\partial}{\partial t} i(z,t)$$

$$\frac{\partial}{\partial z} i(z,t) = -C \frac{\partial}{\partial t} v(z,t)$$

assuming that $R = 0, G = 0$

Please modify them if the line is lossy ($R \neq 0, G \neq 0$).

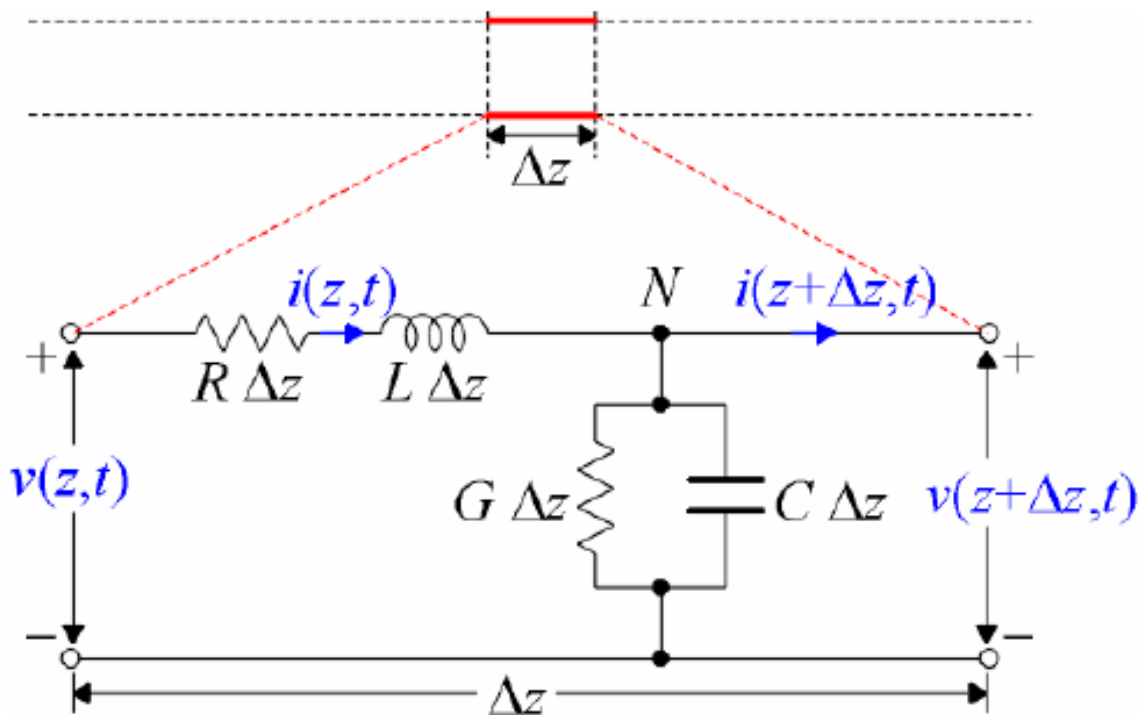


S
o
l
1

A large rectangular area containing horizontal dotted lines for writing the solution.

Q2

For a lossless transmission line we derive the following equation



Equivalent circuit of a real transmission line.

$$\frac{\partial^2}{\partial z^2} v(z,t) = LC \frac{\partial^2}{\partial t^2} v(z,t)$$

$$\frac{\partial^2}{\partial z^2} i(z,t) = LC \frac{\partial^2}{\partial t^2} i(z,t)$$

assuming that $R = 0, G = 0$

Please modify them if the line is lossy ($R \neq 0, G \neq 0$).

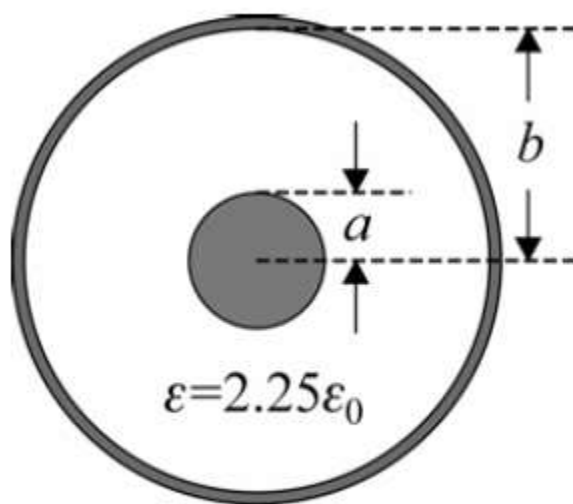


Sol
2

A large rectangular area containing horizontal dotted lines for writing the solution to problem 2.

Q3

(10%) The cross-sectional geometry of a widely used coaxial cable RG58/U is shown in Fig. (below), where the parameters are: $a = 0.45$ mm, $b = 1.47$ mm, permittivity of vacuum $\epsilon_0 = \frac{1}{36\pi} \times 10^{-9}$ (F/m), permeability of vacuum $\mu_0 = 4\pi \times 10^{-7}$ (H/m). By Table of the textbook (p447), the inductance and capacitance per unit length of a coaxial cable are formulated as: $L = \frac{\mu_0}{2\pi} \ln\left(\frac{b}{a}\right)$, $C = \frac{2\pi\epsilon}{\ln(b/a)}$. Evaluate L , C , v_p , Z_0 of a RG58/U cable, respectively. (The numbers will remind you of the typical ranges of these parameters in the real world.)



Cross-section of RG58/U coaxial cable.



Parameter	Two-Wire Line	Coaxial Line	Unit
R	$\frac{R_s}{\pi a}$	$\frac{R_s}{2\pi} \left(\frac{1}{a} + \frac{1}{b} \right)$	Ω/m
L	$\frac{\mu}{\pi} \cosh^{-1} \left(\frac{D}{2a} \right)$	$\frac{\mu}{2\pi} \ln \frac{b}{a}$	H/m
G	$\frac{\pi\sigma}{\cosh^{-1} (D/2a)}$	$\frac{2\pi\sigma}{\ln (b/a)}$	S/m
C	$\frac{\pi\epsilon}{\cosh^{-1} (D/2a)}$	$\frac{2\pi\epsilon}{\ln (b/a)}$	F/m

Note: $R_s = \sqrt{\pi f \mu_c / \sigma_c}$; $\cosh^{-1} (D/2a) \cong \ln (D/a)$ if $(D/2a)^2 \gg 1$. Internal inductance is not included.

