Prof. Yen-Chieh Huang
Dept of Electrical Engineering
National Tsing-Hua University
office: Delta 856
ext: 62340
email:ychuang@ee.nthu.edu.tw

Your name: ________________ ID: ________________ Dec. 14th, 2020

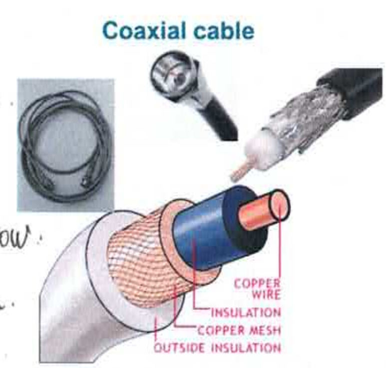
EE214000 Electromagnetics, Fall, 2020
Quiz #13-2, Open books, notes (18 points), due in class, Monday, Dec. 14th, 2020

1. The power supply of a long solenoid delivers a current of 10 A. If you'd like to have an axial magnetic flux density of 1 Tesla on the axis of the solenoid, what is the density of the wires (number of wires per unit length) you have to wind the solenoid? (5 points) By Ampere's Law: $B = \mu_0 n I \Rightarrow n = \frac{B}{\mu_0 I}$, since

$B = 1$ (Tesla), $I = 10A$, $\mu_0 = 4\pi\times10^{-6}$, we can get $n \doteqdot 80000$

2. A coaxial cable is commonly seen to transmit an electric signal, as shown below. Assume that a uniform current *I* moves in the inner conducting core of the cable and returns in the outer conductor. What is the magnetic flux density at *r* from the axis of the cable, where *r* is larger than the radius of the cable? (3 points)

Note that there are I_{in} moves in the inner conducting core and I_{out} returns to the outer conductor. Since I_{in} and I_{out} has same amplitude and with opposite direction, we know that total current $I_{total} = (I_{in} + I_{out}) = 0$ when r is larger than the radius of cable. Then no matter apply Ampere's law or Biotsavart law, we should get $B = 0$.



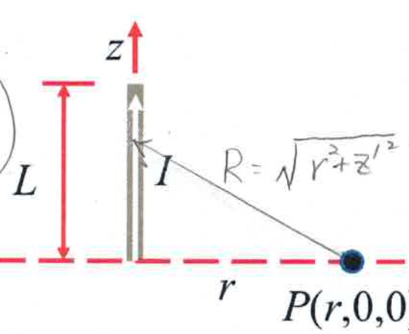
http://en.wikipedia.org/wiki/Waveguide

3. A thin current element of length *L* carries a current *I*, as shown below. Find out the magnetic vector potential and magnetic flux density at point *P*. (10 ponits)

First calculate $\vec{A}$

$\vec{A} = \frac{\mu_0 I}{4\pi}\int_l \frac{d\vec{l}'}{R}$, ($d\vec{l}' = \hat{a}_z dz'$, l is from 0 to L at z direction)

$= \frac{\mu_0 I}{4\pi}\hat{a}_z \int_0^L \frac{dz'}{\sqrt{r^2+z'^2}} = \frac{\mu_0 I}{4\pi}\ln\frac{\sqrt{r^2+L^2}+L}{r}$ ※



Then

$\vec{B} = \nabla\times\vec{A} = \nabla\times(\hat{a}_z A_z) = \hat{a}_r \frac{1}{r}\frac{\partial A_z}{\partial\phi} - \hat{a}_\phi\frac{\partial A_z}{\partial r} = -\hat{a}_\phi\frac{\partial A_z}{\partial r} = \frac{\mu_0 I L}{4\pi r\sqrt{L^2+r^2}}\hat{a}_\phi$ ※