Electromagnetics, Spring 2017

Homework 4

说明：
全用英文作答；
每道题要对所有小问作答，要给出全部必要的推导过程，计算题要算出最终的数值结果，比如开根号之类的；
所有计算出来的结果如果是有单位的物理量，一定要写明单位；
每题的分数在括号中给出；
可以互相讨论，也可以上网查，但是不能抄袭，也不能找别人代做；
所有的解答必须全部是手写的原件，不接受扫描件与照片；
有问题就给我发邮件；
3 月 24 日星期五 10:10 之前交给助教，如到时未完成，可以 3 月 28 日星期二 10 点上课之前交，但是分数会减去 20%。

第一部分 In textbook book *Fundamentals of Applied Electromagnetics*
6.16 (20 points)
6.18 (20 points)
7.7 (20 points)
7.8 (20 points)
7.10 (30 points)
7.11 (10 points)
7.13 (10 points)
7.17 (20 points)
7.18 (20 points)
7.20 (10 points)
7.22 (10 points)
7.24 (20 points)
7.27 (20 points)

第二部分 Homemade
1. (10 points) Why did Maxwell notice that a displacement current is necessary?
2. (20 points) The time-domain magnetic flux density in free space is given by $\vec{B} = \hat{x}B_x \cos(2y)\sin(\omega t - \pi z) + \hat{y}B_y \cos(2x)\sin(\omega t - \pi z)$, where B_x and B_y are constants. Assuming no conduction current exists, determine the electric displacement current density.
3. (10 points) From $c = 1/\sqrt{\varepsilon\mu}$ derive the unit of c.
4. (50 points) If a material has conductivity of 0.4 S/m at 5 GHz and wavelength in it is 2 cm, express its permittivity in a complex number and determine its loss tangent. Assuming the material is non-magnetic ($\mu = \mu_0$), calculate the phase velocity and wave impedance. How big is the phase difference between the electric field and magnetic field of a plane wave propagating in this material? Is this material a good conductor at 5 GHz? Calculate its

complex propagation constant. How many percentage of the electric field intensity is lost after a plane wave propagates 5 cm in this material?

5. (40 points) For a steady surface current density $\hat{x}J_s$ on the *xoy* plane, obtain the magnetic fields generated by this source in both the $z > 0$ and $z < 0$ regions. Then verify that your results agree with the magnetic boundary conditions.