

# Electromagnetics

## 2024 Homework 5

Deadline: TBD

说明:

全用英文作答，中文作答不给分；

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有单位的物理量，一定要写明单位，否则要扣分；

如果是矢量，一定要在字母上面加箭头；

如果相位的计算结果是比较特殊的数（比如  $\pi$ ， $\pi/6$  之类的），可以用弧度表示，如果是很奇怪的数，就用度 $^\circ$ 表示，不要再换算成弧度；

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；

所有的解答可以是手写的原件，或者平板电脑上写的手写版的打印件，因疫情等原因无法返校的同学可以提交电子版；

所有教材上的题号都是英文原版第八版的，不要用中文翻译版第六版的题号；

有问题请给老师或助教发邮件。

Textbook: Fundamentals of Applied Electromagnetics, 8th edition

Part I. Problems in textbook.

**8.4 (50 points)**

**8.16 (20 points)**

**8.9 (100 points)** You need to first do it using the infinite reflection method. Then do it again by assuming all the waves in the medium 2 can be classified to  $Ae^{-jk_z z}$  and  $Be^{jk_z z}$ .

**8.22 (20 points)**

**8.32 (20 points)**

**8.41 (50 points)**

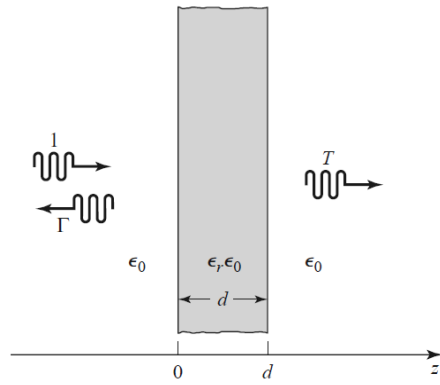
**8.48 (40 points)**

**8.50 (20 points)** You need to specify the four walls by  $x = 0, a$  or  $y = 0, b$ .

**8.52 (20 points)**

Part II. Homemade.

**1. (80 points)** A plane wave is normally incident on a dielectric slab of permittivity  $\epsilon_r$  and thickness  $d$ , where  $d = \lambda_0/(4\sqrt{\epsilon_r})$  and  $\lambda_0$  is the free-space wavelength of the incident wave, as shown in the accompanying figure. If free-space exists on both sides of the slab, find the reflection coefficient of the wave reflected from the front of the slab. Then try it again using  $d = \lambda_0/(2\sqrt{\epsilon_r})$ .



**2. (30 points)** An empty X-band (8.2–12.4 GHz) rectangular waveguide, with dimensions of 2.286 cm by 1.016 cm, is to be connected to an X-band waveguide of the same dimensions but filled with lossless polystyrene ( $\epsilon_r = 2.56$ ). To avoid reflections, an X-band waveguide (of the same dimensions) quarter-wavelength long section is inserted between the two. Assume dominant-mode propagation and that matching is to be made at 10 GHz. Hint: use the conclusion obtained in problem 8.9. Determine: (a) Wave impedance of the quarter-wavelength section waveguide. (b) Dielectric constant of the lossless medium that must be used to fill the quarter-wavelength section waveguide. (c) Length (in cm) of the quarter-wavelength section waveguide.

**3. (20 points)** An attenuator can be made using a section of waveguide operating below cutoff, as shown in the accompanying figure. If  $a = 2.286$  cm and the operating frequency is 12 GHz, determine the required length of the below-cutoff section of waveguide to achieve an attenuation of 100 dB between the input and output guides. Ignore the effect of reflections at the step discontinuities.

