Electromagnetics

2022 Homework 5

Deadline: to be announced later

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；

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 π，$\pi/6$ 之类的），可以用弧度表示，如果是很奇怪的数，就用度° 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；

所有的解答必须全部是手写的原件，不接受扫描件与照片；

有问题请给老师或助教发邮件；

Textbook: Fundamentals of Applied Electromagnetics, 7th 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_2z} and Be^{jk_2z}.

**8.22 (20 points)**

8.30 (20 points)

8.36 (50 points)

8.40 (40 points)

8.42 (20 points) You need to specify the four walls by $x = 0$, a or $y = 0$, b.

8.44 (20 points)

Part II. Homemade.

1. (80 points) A plane wave is normally incident on a dielectric slab of permittivity εr and thickness d, where $d = \lambda_0/(4\sqrt{\varepsilon_r})$ and λ_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 $d = \lambda_0/(2\sqrt{\varepsilon_r})$.
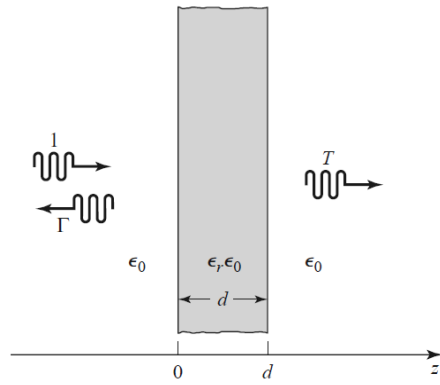
2. (30 points) An empty X-band (8.2–12.4 GHz) rectangular waveguide, with dimensions of 2.286 cm by 1.016 cm, is to be connected to an X-band waveguide of the same dimensions but filled with lossless polystyrene ($\varepsilon_r = 2.56$). To avoid reflections, an X-band waveguide (of the same dimensions) 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.