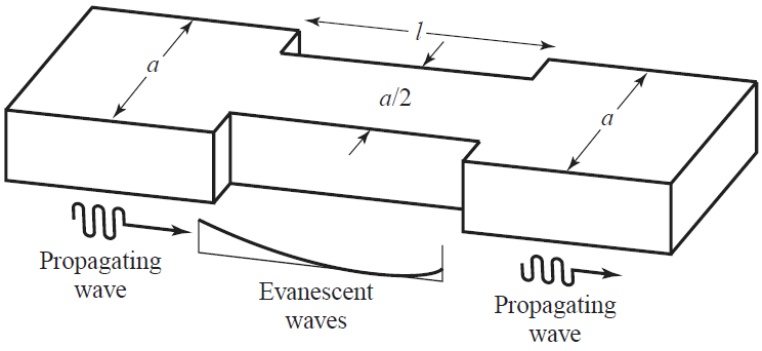
Electromagnetics, Spring 2019

Homework 7

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；
5 月 7 日星期二上课之前交，如到时未完成，可以 5 月 9 日星期四上课之前交，但是分数会减去 20%。

第一部分 In textbook book *Fundamentals of Applied Electromagnetics*, 7th edition
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)

第二部分 Homemade
1. (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.
2. (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.



3. (50 points) Assume only TE_{11} and TM_{11} modes are propagating in an air-filled X-band (8.2–12.4 GHz) rectangular waveguide. Calculate the cutoff frequency of these two modes. At 20 GHz, calculate the total time-average power passing a transverse cross section of this waveguide. Assume the maximum amplitude of E_y of the two modes are both 1 V/m. Hint: you need to use the TOTAL E and H fields to do this. Then individually calculate the time-average power of the TE_{11} and TM_{11} modes. Now you need to use the separate E and H fields of these two modes.