

ECE 5180/6180 Midterm III (Waveguides and Noise)
April 24, 2002

Name Key

Student # _____

SS# _____

You may use your portfolio and calculator, but no text. You can do this!

1. (40 points) Rectangular Waveguides

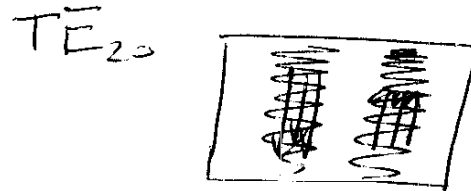
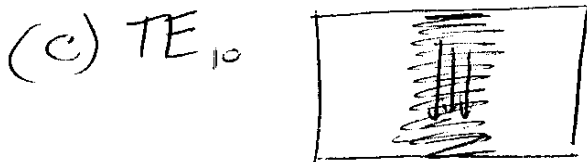
An waveguide has inside dimensions of 6 x 1 cm .

- (a) What are the first three waveguide modes and their cutoff frequencies?
- (b) What frequency range should you use if you only want to have one mode propagating?
- (c) Assume the wave is propagating in the z-direction. Sketch the magnitude of the Ey field for the first two modes of propagation. Show the x-y plane, and SHADE your figures, using a dark shading where |Ey| is large, and light shading where the |Ey| is small.

$$(a) f_c = \frac{c}{2\pi} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

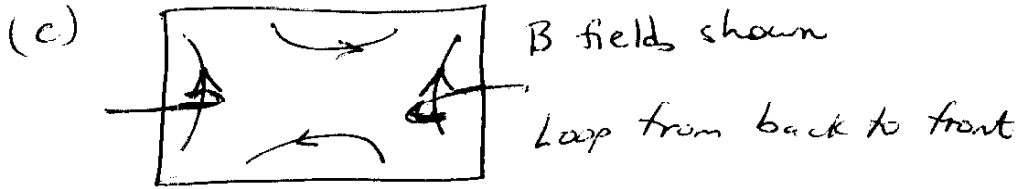
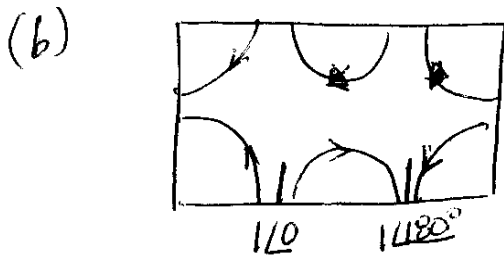
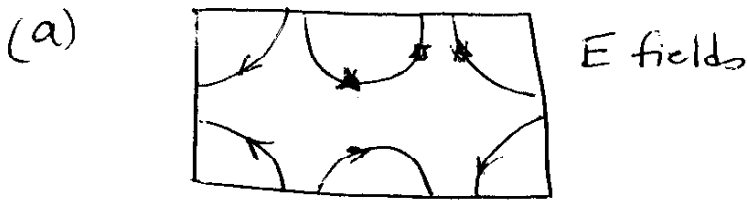
| | m | n | fc | |
|------|---|---|-------|-----|
| TE | 1 | 0 | 2.5G | ✓ ① |
| TE | 2 | 0 | 5.0G | ✓ ② |
| TE/m | 1 | 1 | 15.6 | |
| TE | 0 | 1 | 15G | ✓ |
| Tm | 1 | 2 | 30.1G | |
| TE | 3 | 0 | 1.5G | ✓ ③ |

$$(b) TE_{10} \quad 2.5G \leq f_c \leq 5.0G$$

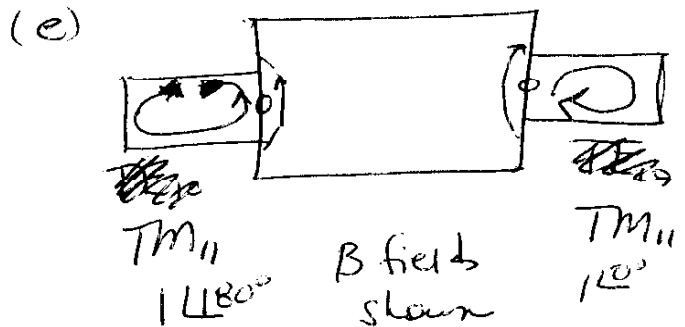
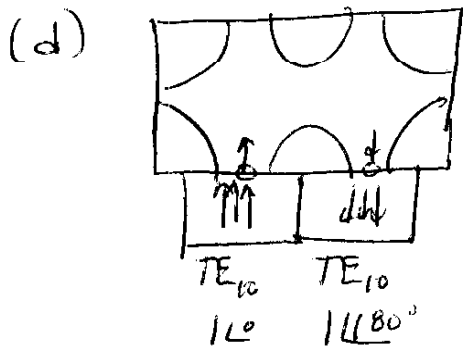


2. (40 points) Waveguide Feed Systems

- (a) Sketch the electric fields for the TE_{21} mode.
- (b) Show where to place probe feed(s) to feed this mode, and indicate which feeds are in and out of phase.
- (c) Show where to place loop feed(s) to feed this mode, and indicate which feeds are in and out of phase.
- (d) Show how to feed the electric fields of this mode with a waveguide aperture.
- (e) Show how to feed the magnetic fields of this mode with a waveguide aperture.

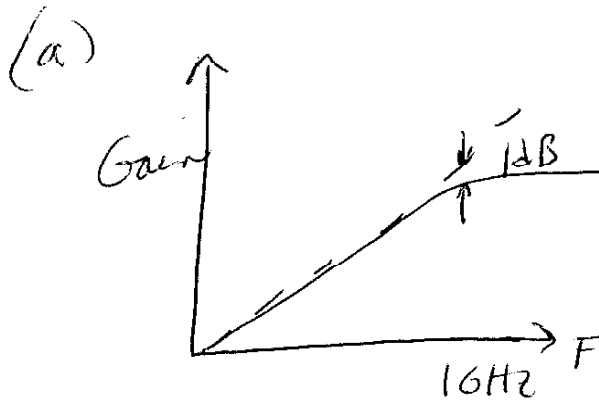


Alternatively could feed top/bottom



3. (20 points) Noise

- (a) An amplifier has a 1dB compression point at 1 GHz. What does this mean?
(b) An amplifier has an equivalent noise temperature of 350 K and is used in a room that is 290 K ambient temperature. What does this mean?



It means that the gain is nearing saturation and is 1dB below ideal.

(b) $P_n = kT_e B$
 ↑
 350K

It means there is extra noise due to the active amplifier, and this noise is the same as a passive device @ 350°K.

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Problem 1 _____ / 40 points

Problem 2 _____ / 40 points

Problem 3 _____ / 20 points

Total _____ / 100 points