EE3140 Quiz 4, Fall 2014

1. Given a rectangular waveguide air-filled with dimensions $a=2.29\text{cm}$, $b=1.02\text{cm}$, what operating frequency would be chosen if we wished to operate at the average of the two lowest propagating (cut-off) frequencies? (5 points)

Solution:

$$f_c = \frac{1}{2\sqrt{\mu_0\epsilon_0}} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

$$= \frac{3 \times 10^8}{2} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

Therefore:

$TE_{10} = 6.55\text{GHz}$

$TE_{20} = 13.10\text{GHz}$

$TE_{01} = 14.71\text{GHz}$

So, average of two lowest is: $(6.55 + 13.10)/2 = 9.83[\text{GHz}]$

2. Given a dielectric slab used as a waveguide with $\epsilon_r = 4$ and thickness $2d = 2\text{mm}$, surrounded by air. What is the cut-off frequency of the $TE_1$ mode? (5 points)

Solution:

$$f_c = \frac{n}{2d\sqrt{\mu_0(\epsilon_r - 1)\epsilon_0}}$$

$$= \frac{3 \times 10^8}{2 \times 10^{-3}\sqrt{3}}$$

$$= 86.6[\text{GHz}]$$