EE 529 Homework #3 (due on 5/5/2016)

1. (30%) Write a computer program to solve the dispersion relation

\[ V \sqrt{1-b} = m \pi + \tan^{-1} \left( \frac{b}{1-b} \right) + \tan^{-1} \left( \frac{b+a}{1-b} \right) \].

(a) We wish to fabricate a planar waveguide in GaAs (n = 3.6) for light of wavelength \( \lambda = 1.3 \text{ \mu m} \) that will operate only in the fundamental mode. Assuming the cover layer is air and the substrate has a refractive index \( n_s = 3.5 \), what range of the GaAs layer thickness can be? (b) If we want to achieve maximum confinement for the waveguide in (a), what should we choose for the thickness of the GaAs layer? What is the corresponding effective guide index for the light? (Note: You can refer to the figure shown in Slide 18 of the supplementary slides for maximum confinement, or you can generate the curves and solve for the result yourself. Then use the program you wrote for (a) to solve for the effective guide index.)

2. (30%) Write a program to solve the effective index of a 4-layer planar waveguide as shown below. Assuming TE mode and the wavelength is 1.3 \text{ \mu m}. Plot the modal distribution along x-direction.

3. (40%) Write a program to solve the effective index of a ridge waveguide as shown below, using the effective index method. Assuming TE mode, the width of the waveguide is 1 \text{ \mu m}, and the wavelength is 1.3 \text{ \mu m}. Plot the modal distribution along both x- and y-direction.