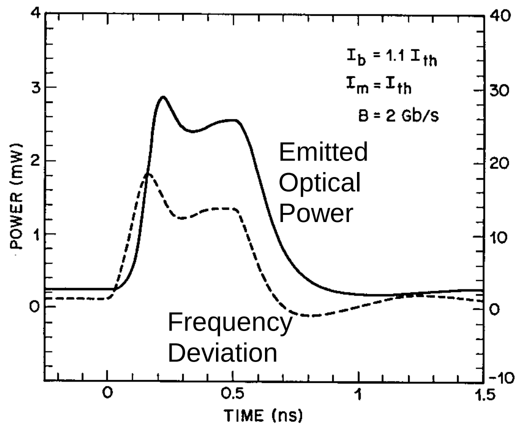
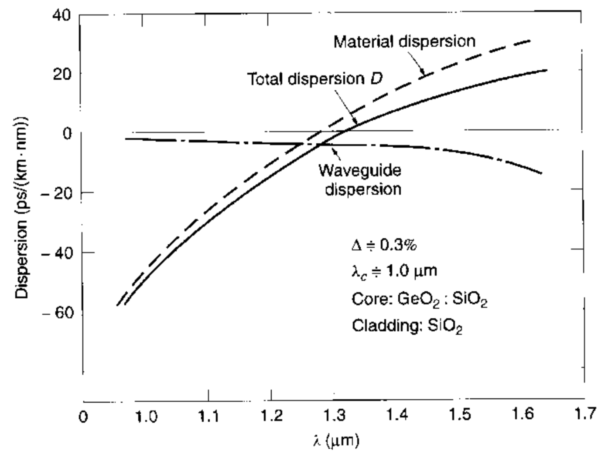
OPTI 500 C, Fall 2011, Take Home Exam

Open notes and open reference material.

Due December 14, 2011

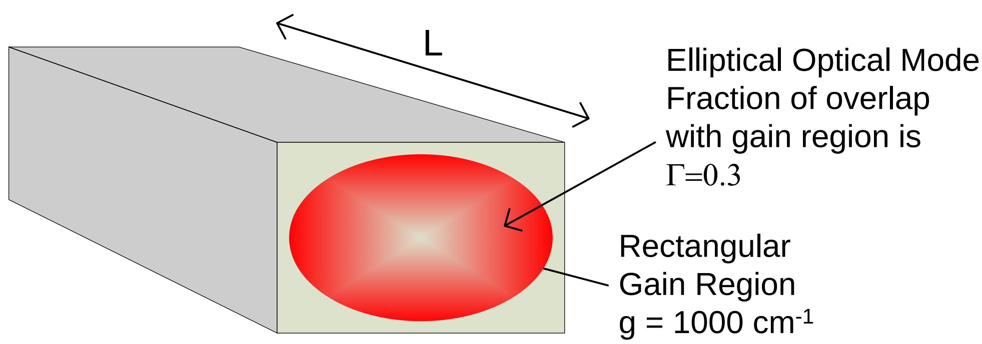
1.





A binary optical signal with a data rate of 2 Gigabits per second and a wavelength of 1.0 micron is transmitted in a standard, single-mode optical fiber. The signal is generated by directly modulating a semiconductor laser. The modulation causes the frequency of the laser to deviate, as shown in the figure on the left above, producing a frequency content in the optical pulse that is larger than the transform limit. Using the dispersion graph on the right above, calculate the pulse spreading after the signal has propagated 40 km.

2.



The optical gain for a semiconductor laser is G = exp(ΓgL), where Γ=0.3 is the confinement factor, g = 1000 cm^{-1} is the gain coefficient in the gain region, and L is the length of the amplifier. Find the length L such that an input signal with an average power of one microwatt is amplified to 0 dBm.

3. In class, we used finite differences for derivatives to discretize the source-free Maxwell Equations and produce update equations for the Finite Difference Time Domain (FDTD) method:

$$E^{n+1/2}(k) = E^{n-1/2}(k) - \frac{\Delta t}{\varepsilon_0} \frac{H^n(k+1/2) - H^n(k-1/2)}{\Delta z}$$

$$H^{n+1}(k+1/2) = H^n(k+1/2) - \frac{\Delta t}{\mu_0} \frac{E^{n+1/2}(k+1) - E^{n+1/2}(k)}{\Delta z}$$

Discretize the equation

$$\frac{\partial U}{\partial z} = -\frac{j}{2n_{clad}k_0}\left(\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2}\right) - \frac{j}{2n_{clad}}\left(n^2 - n_{clad}{}^2\right)k_0 U$$

(including the refractive index n(x,y)) to find an update equation for the Beam Propagation method.