PHYS 408 2010/11 term 2

Homework problem set #9 problems 1-3
Assigned: 25/03/2011
Written Solution due 01/04/2011 5 PM in Hennings 328
If you collaborated with anyone, please write their name at the top of your HW

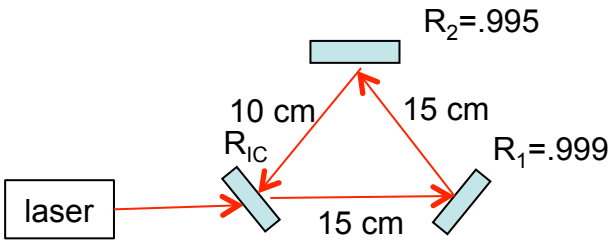
Problem 1 (30 marks) (This isn't a typo)

Look at the midterm #2 solutions I posted and pick one problems that you may have gotten wrong. Describe in words what you may have done wrong and what your misconceptions were. And explain what you didn't understand and what techniques you needed to know in order to solve the problem. Explain in words what you have learned from this.

If you feel you solved all of the problems correctly, then pick a problem and try to find and explain three misconceptions that might lead a person to answer wrongly. To be an expert, you must learn to identify the possible conceptual difficulties that a person may have in order to communicate with them effectively

Problem 2 (20 Marks) :

Another design consideration for using optical cavities to boost cw laser intensities is the amount of input coupling. Consider the ring cavity shown to the right. The reflectivities given are for the field:



a) If the input laser wavelength is not resonant with the cavity where does 100% of the light (even the amount transmitted through the input coupler) go?

b) Now assume the laser wavelength to be perfectly on resonance. Find the amount of input coupling (T'_{IC}) which maximizing the intensity inside the cavity. Note R_{IC} and T'_{IC} are related via the Stokes parameters. if The laser puts out 1W what is the maximum power inside the cavity? Such cavities are used to passively "amplify" lasers to high powers. The given R's are the field reflectivity

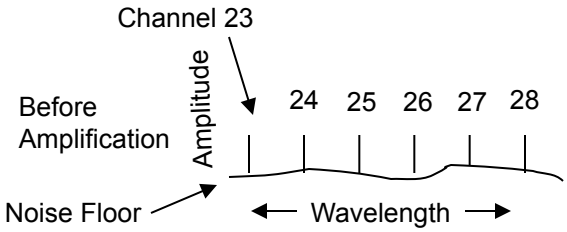
Problem 3 (50 marks)

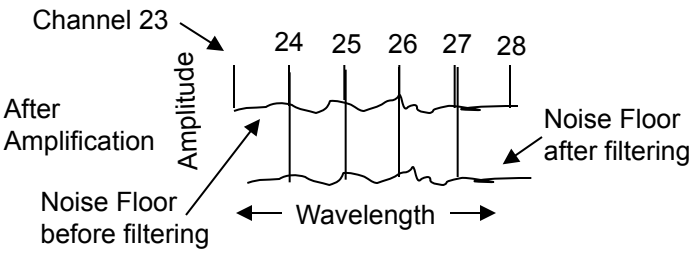
Last night you had a dream. It was the roaring days of Telecom (in the late '90s) where, in companies such as Nortel, money grew on trees. In your dream you are a Nortel optical design engineer assigned to the ultra-long haul division. Your present task is to design an optical filter for a 2000 km transmission system. In order to have a happy ending to your dream, you need to complete this design. Here is some background:

a-The transmission system will be based on a Dense Wavelength Division Multiplexing (DWDM) approach. This means that multiple channels each carrying a different data stream will be transmitted on different optical wavelengths down the same optical fiber.

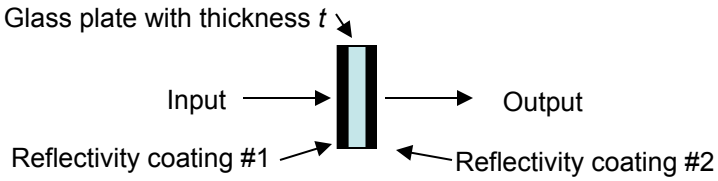
b-The spacing between channels will be 100 GHz (without an offset), as defined by the International Telecommunications Union (ITU) grid (see www.bayspec.com/pdf/ITU-DWDM.pdf). At 1550 nm, 100 GHz corresponds to approx 0.2 nm) You are to design a system that covers channels 21 to 50, as the initial system will carry a total of 30 channels.

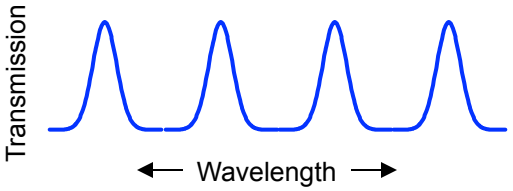
c-For a signal to go 2000 km, it must be periodically amplified with optical amplifiers. As the optical amplifier produces gain at all wavelengths (not just the signal wavelengths), this process adds out-of-band noise to the signals in the following manner:





You are to design a filter to reduce this out-of-band noise. Luckily, you remember that in one of the PHYS 408 classes you learned that a plate of glass with appropriate thickness correct and reflectivity on each face has a transmission function that looks like this:





In order to get the exact index of whichever glass you decide to use you will need to use the sellmeier equation (http://en.wikipedia.org/wiki/Sellmeier_equation) which models the wavelength dependence of glass, Here are the design constraints:

1-The filter must be periodic at 100 GHz in order to let all of the channels through
2-The full-width at half maximum of the transmission at each signal wavelength must be between 10 & 20 GHz.
3-The filter must be polarization independent

You need to provide the glass type, the thickness and the reflectivity of the coatings for your design to be accepted. Assuming the reflection coatings deposited on the glass plate are wavelength independent, will your design cover the ITU S, C and L bands for future upgrades? Why or why not? The filter will not work if it attenuates the center wavelength of a particular channel by more the 10% *Hint: you need to use the sellmeier equation*