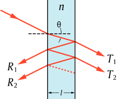
## **ECE 170B Winter 2020 Project 3**

## **Optical resonant cavity**

In this project you will simulate how the properties of a Fabry-Perrot resonator varies with mirror reflectivity, cavity propagation loss, cavity length and temperature. As always, use MATLAB Livescript and turn in the .mlx format. Make sure you label and explain your results so that your answer can be quickly identified. The project is similar to Projects 1 and 2 so it should be clear.

Since you have access to the web, you don’t need an equation sheet but if you do, you can use the one from the midterm which is inclusive of midterm and final.

Problem: A Fabry-Perrot cavity consists of the cavity formed by two highly reflective mirrors placed parallel to each other, as shown in the figure below. The input light beam to the cavity enters the first mirror and the output of the cavity is the light beam leaving the second mirror. The cavity is filled with air and the cavity length L= 50cm. Assume this is a lossless cavity with identical mirrors of reflectivity R=R1=R2=90% (Unless stated otherwise). Assume 800nm wavelength. assume θ=0 degree (normal incidence).



(a) Plot the transmittance of a passive cavity for several FSR as a function of the round-trip phase shift. Redo this for different values of reflectivity: R = 30%, 50%, 70%, and 90%? Plot all in the same chart and explain what you observe.

(b) Calculate the mode number near the center wavelength and corresponding frequency. Plot the cavity Q (Calculate using /Users/zhoutingyi/Library/Group Containers/UBF8T346G9.Office/ConnectorClipboard/image15841460986981.png and /Users/zhoutingyi/Library/Group Containers/UBF8T346G9.Office/ConnectorClipboard/image15841460987002.png) vs. mirror reflectivity from 30% to 99%.

(c) Plot the spectrum for one FSR as a function of the round-trip phase shift for intensity propagation loss of /Users/zhoutingyi/Library/Group Containers/UBF8T346G9.Office/ConnectorClipboard/image15841460987103.png. Plot all in the same chart and explain what you observe. Your x-axis should span roughly one FSR.

(d) With one movable mirror to change the cavity length, the Fabry-Perot cavity forms a tunable filter with its passband center frequency determined by the cavity length. Plot the transmission through a Fabry-Perot cavity with a cavity length of L=50cm and L=30cm. For this plot, your x-axis should span several FSRs.

(e) Plot the spectrum for one FSR as a function of the round-trip phase shift for room temperature, 50 C and 100 C. Assume the temperature coefficient of refractive index is 1E-4 and the thermal expansion coefficient is 9E-6 per degree C. (Plot the one FSR that next to the zero-phase shift mode)