Lab #5 – Variation Analysis - Corner Analysis for MRRs – 100 points.

Submission Link: https://www.dropbox.com/request/N5Y2n5HfRwRW83auLE4W

Due: December 5, 2018 at 23:59 (submission link will be deactivated after 23:59).

Please upload a zip file including your simulation files from Lumerical tools, results (export data), and a lab report (PDF file). What should be included in the lab report? Summary of your approach (how the simulation works, simulation codes/scripts, explanation of different objects and sources in your simulation) and your approach, as well as all the results and plots from the simulations below.

Lab description: Fabrication process variations is inevitable in silicon photonics. When designing a silicon photonic device (e.g., MRR), it is always necessary to include the impact of different variations in the design process. Several methods, such as Monte Carlo and corner analysis, exist that help designers take into account the impact of fabrication process variations during the design phase. For example, Lumerical INTERCONNECT has an embedded Monte Carlo analysis platform that can run variation analysis.

In this lab, the aim is to design an add-drop filter using MRRs, and run variation analysis for the design. **We will then use this MRR with the variations analysis in LAB 6, in which we design a chip for EBeam fabrication.**

We want to design an MRR with the following nominal design parameters. **Note that the nominal width is 450 nm**.

Table I: Nominal Design Parameters

Radius	10 μm
Width	**450 nm**
Thickness	220 nm
Gap	200 nm

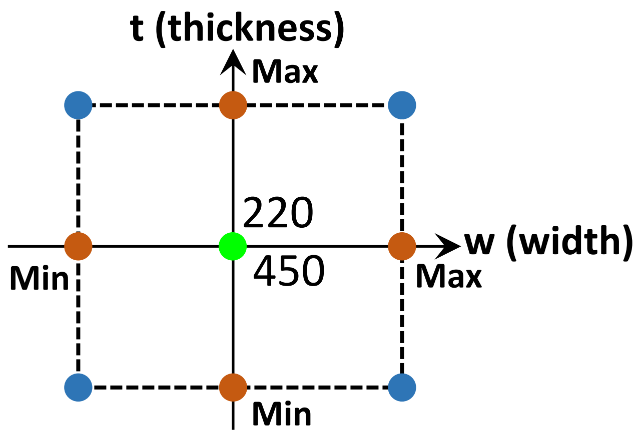
Step 1: Run group index and effective index analysis for a strip waveguide with the above dimensions in Lumerical MODE. Save the results for group index and effective index.

Step 2: Using LAB 3, find the cross-over coupling and straight-through coefficients (κ and t) for the MRR.

Step 3: Using Lumerical MODE, simulate the MRR and plot the optical spectrum from 1500 nm to 1600 nm. Identify the resonant peaks.

Step 4: Using data from Steps 1 and 2, plot the optical spectrum of the MRR using TMM in MATLAB. For better comparison, plot the optical spectrum from MODE and TMM in a single figure. Label the plots.

So far, we have the optical spectrum of the double-bus MRR from TMM and MODE using the nominal design parameters in Table 1. But, we need to include the impact of variations in our simulations. We want to run Corner Analysis to understand how variations impact the performance of our design. The performance here is defined as the resonant wavelength shift in the MRR (Homework 4, Q1). In Corner Analysis, we look into the highest and lowest deviations from the nominal design parameters (i.e., the process corners). For example, the following figure shows different process corners considering the variations in the waveguide width and thickness.



Step 5: Consider the following variations in the width and thickness. For simplicity, we assume that the Gap and the Radius do not vary (this is NOT true in practice). In addition, we assume that the variations in the ring waveguide and those in the input/drop waveguide are the same.

Table II: Variations

Width	$\pm$10 nm
Thickness	$\pm$5 nm

Considering the variations in the waveguide width and thickness, we have several process corners:

Table III: Process Corners (Radius, Thickness, Width)= (10, 220, 450) **Nominal**

(10, 220, 460)	(10, 225, 460)	(10, 225, 450)	(10, 215, 460)
(10, 220, 440)	(10, 225, 440)	(10, 215, 450)	(10, 215, 440)

Repeat Steps 1 to 4 for each of the process corners (9 in total, including the nominal design parameters).

Step 6: Plot the optical spectrum of the MRR from Step 5 (9 cases) in one figure (use either TMM or MODE). Each optical spectrum plot should be in a different color and has a proper label indicating the design parameters (thickness, width).

Step 7: Using the analytical model for the resonant wavelength shift in MRRs (Homework 4, Q1), what is the largest resonant wavelength shift you would expect with the variations listed in Table II? Check if this shift is what you observe from the plot in Step 6.