Optoelectronic Devices and Systems

Passive waveguides and devices

EENGM6020 MSc Coursework November 2023

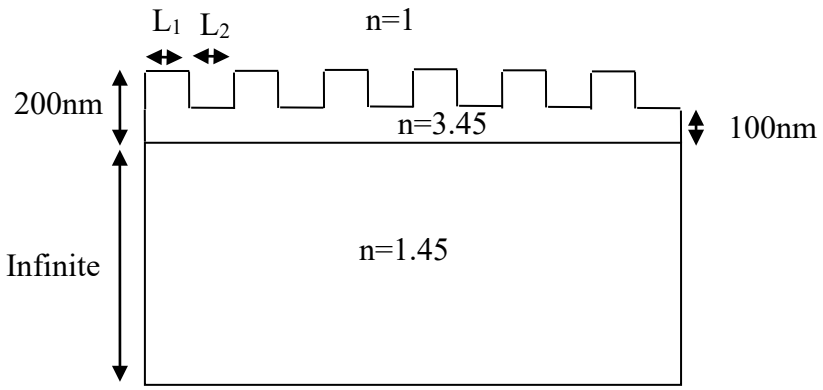
This coursework should take approximately 10 hours to complete

Deadline : 1pm Wednesday 6th Dec 2023 (week 11)

Submitted to Blackboard

1. CAD design Exercise : A Bragg Filter in Silicon-On-Insulator (SOI) (50%)

The picture below shows a cross section through an SOI filter. Calculate lengths L_1 and L_2, the number of periods and hence, the overall length for 90% power reflectivity(r^2) at 1550nm.



$$\lambda_g = \frac{\lambda_0}{n_{eff}} \qquad r = \frac{n_{eff1} - n_{eff2}}{n_{eff1} + n_{eff2}}$$

1. Obtain n_{eff} from : http://www.computational-photonics.eu/oms.html

Note each section L_1 and L_2 will have different n_{eff}
Note : use the fundamental TE modes

2. Use your lecture 6 notes (Professor Cryan's part) to work out what total length of grating is needed for 90% power reflectivity at 1550nm.

3. Use matlab to implement the Transfer Matrix Method. Expand the T matrix and convet back to an S matrix to find S_{11} and hence reflectivity(r) for a given total length of grating.

4. Write a short report (max 3 pages) explaining how you did the filter design. This should include your matlab code which should also be submitted as an .m file.

Mark rubric for part 1:
Pass (>=25%): Calculate n_{effs} for both sections and calculate L_1 and L_2
Merit (>=30%): Complete part 2 with clear reasoning for your answer
Distinction (>=35%): Complete parts 3 and 4

2. Distributed Bragg Reflectors in Active Devices (50%)

A Vertical Cavity Surface Emitting Laser is a key device for communications and sensing. You should write a report consisting of the following sections

a. An explanation of what a VCSEL is and how it differs from an edge emitting laser (200 words). You answer should include at least 3 relevant references to the literature, and include definitions the terms “distributed Bragg reflector”, “cavity” and “gain medium”.

b. **An explanation of how a Distributed Bragg Reflector made of GaAs and AlAs can reflect the light** (200 words) and determine how many GaAs/AlAs pairs are necessary to achieve 90% power reflectivity at 940nm.

c. **A sketched design, with layer thicknesses, for a VCSEL operating at 940nm.** (Diagram, with appropriate dimensions, with 200 words of text to justify design choices).

Mark rubric for part 2:
Pass (>=25%): Complete part 2a, with references appropriately recorded.
Merit (>=30%): Complete part 2a and 2b, with appropriate graphs/calculations/code fully presented.
Distinction (>=35%): Complete 2a, 2b, and 2c with full accurate description of the device, justifying completely all design choices you have made.