

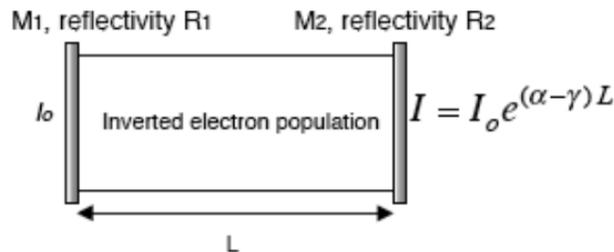
Name:

Student Number:

Quiz 4 ELEC 4705
Tuesday, Nov. 24, 2015

1. (10 marks) Lasers

- (a) Explain the difference between absorption, spontaneous emission and stimulated emission.
- Photon absorbed, raising an electron into the conduction band (electron/hole generation)**
 - Electron, with no stimulus, drops an energy level (electron/hole recombination), emitting a photon.**
 - Incoming photon causes electron in an excited state to drop to a lower energy, emitting a photon. Incoming photon not absorbed so have two photons out. They are in phase and coherent.**
- (b) What are the three key components of a laser?
- **Gain medium**
 - **Pumping mechanism**
 - **Parallel mirrors at the two ends.**
- (c) Draw the basic structure of a laser.



- (d) What is a population inversion and how do we achieve it in a semiconductor laser?
Occurs when $n_2 > n_1$. Achieved by pumping.
- (e) What is the “threshold current” in a semiconductor laser? Define it in terms of the laser operation.
The threshold current is the current at which number of photons being produced by stimulated emission due to the recombination of the electrons and holes in the active region is equal to all optical losses in the system. Above this current the system starts to “lase”.

2. (10 marks) IC Fabrication

- (a) What are the two types of deposition? Describe them and give an example of each.
- **Physical: target is bombarded with ions which adhere to the target's surface. Example is sputtering.**
 - **Chemical: target exposed to ongoing chemical reaction to form the desired material on target's surface. Example is CVD.**
- (b) What is the primary goal of photolithography?
The primary goal is the transfer of patterns or images to the surface of the wafer.
- (c) Describe the three basic steps in photolithography.
- i. **Deposition (spinning/coating) of photoresist on the surface of the wafer.**
 - ii. **Exposure of the photoresist to an optical image.**
 - iii. **Developing of the image in the photoresist.**
- (d) During the fabrication of an epitaxial diode, what process occurs between the highly doped n^+ buried layer and the epi layer of crystalline silicon?
Diffusion.
- (e) What is a method by which we could deposit the metal for a transistor contact on to Si?
Sputtering or CVD