Examination Feedback for EEE337 – Semiconductor Electronics
Spring Semester 2015-16

Feedback for EEE337 Session: 2015-2016

Feedback: Please write simple statements about how well students addressed the exam paper in general and each individual question in particular including common problems/mistakes and areas of concern in the boxes provided below. Increase row height if necessary.

General Comments:

Question 1:

Most students did well in this questions. Some students however could not draw the current-voltage curves in the dark and when illuminated with light. For part (d) a number of students correctly described thin film solar cell as the lower cost solar cell which has lower efficiency. Use of tandem cell with microcrystalline Si can improve the efficiency. Alternatively other thin film technologies are also acceptable answers.

Question 2:

This is largely based on book-work and I was surprised to see students struggled. (a) it is obvious that the conditions required to achieve lasing is population inversion and high photon intensity. (b) most standard lasers are fabricated in the form of stripe laser, i.e Fabry Perot structure, where the length should be L= N*Lamda/2. A description of this laser that includes highly polished mirrors, roughen sides to prevent buildup of unwanted wavelengths, cladding with different refractive index and highly doped p and n layers should be included. (c) The Fabry Perot structure will support a number of modes and hence produces multiple wavelengths. (d) DFB or DBR would be the obvious solution. Some students have described use of MQW as to provide narrower emission spectrum which is acceptable but will not achieve the full marks for section (d).

Question 3:

Parts (a) and (b) are based on book-work. A number of students have not attempted these and therefore dropped marks from this question. Clearly electrons and holes have slightly different energies due to thermal broadening and hence the broad emission spectrum. The lifetime of spontaneous emission is relatively long and limits the maximum modulation rate. In part (c) most students correctly identify the bandgap required for emission at 800 nm. Some students have been able to also correctly described that a double heterostructure would be required to achieve bright emission. A small number of students incorrectly described QCL, which is adopted for much longer infrared wavelengths, as the answer.
In part (d)(i) note that Jh is the minority hole diffusion current and therefore it is strongly dependent on the n-layer. A number of students have incorrectly described the changes in the p-layer as the way to reduce Jh. In (d) (ii) many students have failed to use the equation for W given in the appendix to analyse the effect of doping in the i-layer. Increasing the doping will reduce the depletion layer W, which in turn reduces IGR. Therefore it can be seen that if IGR reduces, the injection efficiency can be improved. Finally when analyzing the effect of temperature, many of you failed to recognized that the intrinsic carriers, minority electrons and minority holes, will all increase with temperature. Hence Je, Jh and JGR all increases with temperature leading to reduced injection efficiency.

Question 4:

Most did well in parts (a) and (b). Part (c) which is also based on book-work is less well answered. It is important to use the velocity-electric field diagram to explain how the phase shift is achieved in Gunn diodes. For part (d), it is clear that at higher frequencies, the best option is to make use of devices that do not rely on transit time. Therefore IMPATT is not an attractive option. Tunneling diodes or resonant tunneling diodes would be appropriate for higher frequencies.

Question 5:

Question 6:

Question 7:

Question 8: