Examination Feedback for EEE348 – Electronics and Devices
Spring Semester 2015-16

Feedback for EEE348 Session: 2015-2016

General Comments:

Question 1:

Most people did this question and it was reasonably-well attempted. In part b, some people still get mixed up with what to invert and how to interpret switch state/logical state. Part e was the least-well answered part of the questions. People did not recognize that an undershoot on the output could forward bias the substrate pn junction. Nor did they identify that a possible solution is to use bigger diodes with a smaller Vf to limit excursions of the voltage

Question 2:

This is a relatively standard question (with more bookwork than Q1) and very few people did it. Those who did so generally did quite well.

Question 3:

Part a: descriptions of the three terms was poor. It was not enough to simply state formulae for the terms.
Part b: students did well with the calculations in section I and the small signal model in section ii. In section iii some workings were required to gain full marks, and some students stated the wrong formula (that of a source follower) and ended up with a gain ~1!
Part c: all sorts of odd arrangements of transistors and connections were tried here, marks were awarded when two PMOS devices were shown back to back, with connected gates, and with the reference arm shown 'diode connected'.

Question 4:

Part a: most students could suggest a current mirror as an alternative to the potential divider for biasing, but descriptions as to why this was better were lacking. Marks were given for talking about feedback, temperature dependence of transistor operation, physical space on the IC substrate…
Part b: small signal modelling was fine. Full marks required describing assumptions in section ii – e.g. that the parasitic capacitances could be considered open circuits at midband frequencies. Most students got the Miller capacitances correctly, and could describe where they would connect. Again, in section iv, assumptions needed to be stated to gain full marks – e.g. that the gain at the cutoff frequency is approximately equal to the midband gain.

Question 5:

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 6:

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 7:

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 8:

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.