Examination Feedback for EEE6216 – Energy Efficient Semiconductor Devices
Spring Semester 2014-15

Feedback for EEE6216 Session: 2014-2015

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:

This is the first year of this course and it is pleasing that the final marks were in a good range. Some weaknesses in overall understanding particularly on the most basic fundamentals of LED, solar and electronic/photonic device technology have been seen which need to be addressed next year

Part A:

Part A consisted of 16 short questions requiring in some cases a single line answer or in some others (dependent on the mark) perhaps up to a short paragraph. Most students did most of the questions well enough, though it appeared that many had a lack of time (several complained on this matter). Students need to resist the temptation to give longwinded answers as short, snappy answers are more appropriate for this section. .

B1:

This question tested the knowledge of the most fundamental of parameters of a solar cell. There were some good scores, but a disappointing number of students had problems with calculating the basic parameters of the solar cell which is one of the most fundamental parts of this course

B2:

The question tested knowledge of LED technology and contained a mixture of calculations and some bookwork. Overall those who did this question did it well, except for perhaps the last part on extraction efficiency which confused some students

B3:

This question was related to power consumption in microprocessor based devices. Most parts were answered very well, but a few students had problems with parts (iii) and (iv). Most could describe the advantages of LED illuminated displays and their construction process.

B4:

This question on photonic devices was largely ignored by most students, suggesting that there were not so familiar with the concepts/terminology. The questions are not more difficult than any other section, but for some reason students just completely switched off on this part.

Coursework (mock test):

This was prepared partly to give experience, but also provided a few marks to the coursework. Some good scores were seen, but also some shockingly weak performances including at least a dozen fails. We designed this to be a very simple and quick revision paper, as easy as we could make it without losing credibility and so were very concerned by some of the poor returns. Either students did not take this mock exam seriously, or were unfamiliar about what an exam paper is or what an exam situation looks like. Quite a bit of talking and the occasional look over of a shoulder at another student was observed during this test. In future we will have to make it clear that this mock test is important/serious and must be done under strict exam conditions

Coursework (Detectors):

In the introduction most students were able to provide some description of blackbody radiation, a typical component list of radiation thermometer and some examples of application. A brief description of the aim of the design is then provided. This is sufficient for the introduction.

Students typically then list the Planck's Law and a number of students correctly demonstrated that they were able to calculate the emitted energy as a function of wavelength at temperature of 100 and 150 C. Since these curves are required to determine the suitable wavelength range of the detector, they must be included in your report. Some students have simply calculated the peak emission wavelength. Although this will work, it is not the best practice since the tolerance to measurement error is higher at shorter wavelengths (as stated in the lecture notes).

From the calculated energy spectrum, it should be possible to identify suitable wavelength range. Here some students have simply provided the peak wavelength, which is not accurate. If you have obtained the correct energy spectrum you would note that the appropriate wavelength range would be between 1-3 μm. Hence suitable detectors are InGaAs, extended InGaAs and InAs. Although PbSe and PbS can also be considered, they are typically offered as photoconductor, which is not compatible with the transimpedance amplifier given in the design.

Next it is important to extract the responsivity $R(\lambda)$ of the chosen detector from commercial detector data sheet. Note that the responsivity as a function of wavelength is needed. Many students simply use the peak responsivity to perform the integration for calculating the photocurrent.

Using $R(\lambda)$ and $L(\lambda,T)$, [not the peak responsivity and peak emitted energy], the photocurrent can be obtained. You should select a detector that will produce 10s of mV. Some students have chosen very long wavelength detector which produces high photocurrent (and very larger voltage). This is not necessarily the best option as typically they require cooling, are less stable and more expensive.

In the justifications, the following should be include

- Choose the shortest possible wavelength range to increase tolerance to measurement errors.
- Choose photovoltaic, not photoconductor to be compatible with transimpedance amplifier that converts current to voltage. (note that usually the output of photoconductor is voltage).
- The detector with the shorter wavelength range should also produce lower dark current, below 100 nA.
- Choose detectors that do not require cooling and hence it is cheaper.
- You should also comment on the fact that the ratio of photocurrent to dark current is sufficiently large.

Overall most students demonstrated some ability to select the detector, but with some shortcomings in some parts of the design.

Coursework (Solar Cells & LED lighting):

Some very good bookwork and calculations done by many students. All did the basics well, however some students were able to bring in more detailed research findings or discussions which made for more accurate forecasts and were rewarded with high scores. Almost all the group was able to come up with some sensible estimates of installation costs and payback times, giving overall conclusions that both Solar and LED technology would pay off for the University over a reasonable time period of 10-15years.