

ECE 371 Knowledge Probe – Fall 2009

1. Instrument

The knowledge probe (KP) consisted of five questions given to students in the class as a separate survey exam. Due to some arrangement difficulties, this knowledge probe was taken after the middle of the semester, instead of the beginning of it. The class was taught by Prof. Ed Graham. Students were given twenty minutes for this survey exam. The KP's returned by the students are attached.

Question 1

This question was meant to address outcome A. The knowledge necessary to answer the question should have been gained in Physics 262 (course prerequisites). The definition of “electronvolt” or eV is a fundamental basis for quantum mechanics. The students are expected to know what eV is and how much joules is equal to an eV. *A priori*, I expected 90% of the students to answer this question correctly.

Question 2

This question was meant to address outcome A. The knowledge necessary to answer the question should have been gained in ECE 371 (current course). The mass-action law in a semiconductor material is a fundamental basis for quantum mechanics. *A priori*, I expected 90% of the students to answer this question correctly.

Question 3

This question was meant to address outcome E. The knowledge necessary to answer the question should have been gained in Physics 262 (course prerequisites), as well as in ECE 371 (the current course). The question itself dealt with Planck relationship, which is also a fundamental basis for quantum mechanics. I expected 90% of the students would answer the question correctly.

Question 4

This question was meant to address outcome E. The knowledge necessary to answer the question should have been gained in ECE 371 (the current course). The question dealt with Fermi-Dirac distribution. I expected 90% of the students know the definition of Fermi-Dirac distribution, and 60% of the students remember the formula.

Question 5

This question was meant to address outcome A. The knowledge necessary to answer the question should have been gained in ECE371 (the current course). The question dealt with energy-band diagrams. I expected 90% of the students understand what energy-band diagram is.

2. Results

Nineteen students took the knowledge probe, and eighteen students answered every question and only one student answered three questions and left two blank. Thus, the allotted time appears to be sufficient for all students to answer the questions to the extent necessary to demonstrate their knowledge.

Question 1

Eleven students answered the question completely or essentially correctly. Two others answered the question with minor error, and six didn't know the answer or had forgotten how to solve it.

Question 2

Only two students answered almost correctly with minor error and five others knew but had forgotten the answer. Twelve students could not answer this question. Most students didn't know what mass-action law is.

Question 3

Six students solved the problem completely correctly and three students solve it with minor error. Eight students knew how to solve it but didn't remember the equations. Two students left the question blank. It seems that if the students were given Plank relationship, they mostly would have been able to solve this problem.

Question 4

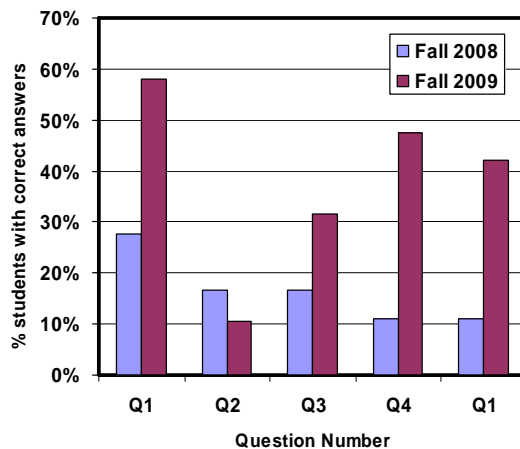
Nine students answered completely correctly, and eight students knew how to solve it but didn't remember the equations. Two students left the question blank or had complete wrong answer. Although answering this question wouldn't need the Fermi-Dirac equation, it seems that if the students were given the equation, they mostly would have been able to solve this problem.

Question 5

Eight students answered completely correctly, and six students answered it with minor errors. Five students had forgotten the concept of energy band diagram. No student left the question blank. This question doesn't require the students to memorize the band diagram, but to understand the concept of bandgap and how it relates to the conductivity of the materials.

3. Analysis

As shown below, compared to last years knowledge probe, the number of students with correct answers has increased significantly, except for the second question.



Overall, the basic knowledge of quantum mechanics and knowledge of the students (definitions of physical parameters and basic concepts) actually exceeded my expectations. All students in the class seemed to have little or no trouble understanding the basic concepts. However, students appeared to have run into trouble by “memorizing formulas”, instead of being able to apply a fundamental understanding of the underlying concepts to physics of semiconductor materials. Moreover, through discussions with the course instructor, it was revealed that the students mostly suffer from their weak math background.

4. Suggested Actions and Follow-up

Since the prerequisite course (Physics 262) is taught outside our department, there is not much that can be done to change the way that the student think about device physics. However, I recommend that for the current course (ECE 371) the emphasis should be placed on understanding underlying fundamentals, rather than “application of formulas” to straightforward problems. Perhaps more practice to some fundamental quantum mechanics could help the students, in particular.

Currently, the only prerequisite for ECE 371 is Physics 262. Even though by the time that the students take ECE 371, they should mostly finish their math courses, it might also be beneficial to consider Math 264 as an additional prerequisite for this course.