ECE238
Fall 2008
Knowledge Probe Analysis

Course Coordinator: Prof. Marios Pattichis
ABET Outcomes probed: A B C E
Relevant pre- and co-requisite classes: ECE 131

1. Probe instruction

The knowledge probe (KP) quiz consisted of six questions. To encourage the students participate in the assessment, this quiz was given to the students and counted as part of their grades in the class. The students were given 30 minutes to answer the questions in class in the last week of the semester. The KPs returned by the students are attached.

2. Probe purposes

Question 1
This question was meant to address outcomes A and E. This question was meant to determine if students gained a basic understanding and could design combinational circuits that use NAND and NOR gates. I expected 90% of the students to answer this question correctly.

Question 2
This question was meant to address outcomes A and E. The knowledge necessary to answer the question is the understanding of sequential circuit design. This problem probes students' understanding of the relationship between states and flip-flops. I expected 80% of the students to get this question correctly.

Question 3
This question was meant to address outcome E. This problem more obviously leads to the use of a Karnaugh map as it asks for the minimum number of gates, phrasing that is commonly associated with Karnaugh maps. I expected that at least 80% of the students could perform this task successfully.

Question 4
This question was meant to address outcomes C and E. In real design applications, it's not always possible to find devices with the exact number of input lines required. Some inputs must be tied to the extra lines, but students are not always confident about what kind of input is needed. This question probes students' ability to design combinational circuits with MSI components such as decoders and the ability to solve a problem with a limited set of devices. I expected 80% of the students could solve this question correctly.

Question 5
This question was meant to address outcomes C and E. This question probes the ability to convert a verbal specification into a Boolean expression to solve the practical problems. I expected 80% of the students to correctly answer this question.

Question 6
This question was meant to address outcomes C and E. The knowledge necessary to answer the question is to translate sequential circuit specifications into state diagrams and design general sequential circuits. I expected 80% of the students to correctly answer this question.

3. Probe results

Totally 35 students (38 students are registered in the class) took the knowledge probe quiz. The results for each question are outlined as follows:

Question 1
Every student answered this question. 83% of the students (29 students) answered the question correctly, but five of them did not give a complete detailed explanation. Only 17% of students (6 students) didn't answer this question correctly.

Question 2
52% of students (18 students) remembered that the minimum number of flip-flops needed for n states is $\log_2(n)$, but this problem cannot be solved by recalling that fact only. Seven students gave the correct answer for this question. 46% of students (16 students) gave the wrong answer of 2*m. This mistake maybe due to a lack of understanding of how states in a state diagram are related to flip-flop outputs or maybe due to a lack of a basic understanding of log functions.

Question 3
69% of students (24 students) realized this question asked for the minimum number of gates, which should lead to the usage of a K-map. 20 students answered this question correctly. Four students used K-maps, but they could not arrive at the correct result since they were not correctly filling their K-maps or identifying minimal rectangles in their K-maps. Six students used the sum of products form and tried to use Boolean algebra to simplify it, but they could not get the simplest and correct answer either. Five students did not attempt the question, they just had wrong guesses.

Question 4
80% of the students (28 students) used the decoder correctly. Thirteen students had a correct answer for this question. But some of them ignored the "non-trivial" input/output for the fixed number inputs of the given gates. Fifteen students gave partially correct answers. They could not figure out how to use the given NOR gates instead of OR gates for the Product of Sums forms. Six students gave wrong answers. They appear to have misunderstood the decoder and used K-maps instead. One student did not attempt this question.

Question 5
54% of the students (Nineteen students) answered this question correctly. Six students understood they needed to convert a verbal specification into a Boolean expression directly, but they could not arrive at the right answer. Nine students did not have the correct solution, they used the truth table and K-map and got the wrong answer. One student didn't know how to solve it.

Question 6
66% of students (23 students) could draw the state diagram, give the state table and synthesize the circuit. Twelve students answered this question total correctly. Eleven students drew the state diagram correctly, but they made mistakes in the synthesis and got the final sequential circuit wrong. Eight students had drawn the state diagram wrongly or did not even provide a state diagram. The question appeared on the last page and this may have contributed to the fact that four students missed it.

4. Analysis and Recommendations

The knowledge probe results revealed some digital logic concepts that many students did not understand completely:

1) K-map and simplification in different application contexts,
2) How to handle non-trivial input/output,
3) Relationship between states and flip-flops,
4) MSI components in circuit design,
5) How to solve a problem with a limited set of devices,
6) State diagram and Moore and Mealy sequential circuit design,
7) Directly use Boolean expression to solve the practice problems.

Some of these misconceptions are anticipated, others were very surprising, such as problems with working with K-maps and decoders.

Overall, the students' answers are close to my expectations. In order to improve student learning, we can emphasize the concepts outlined above that appear to be difficult for students to understand. Instructors can change the relative course materials or teaching methods to focus on these difficult concepts and prepare more examples and large problem sets with lots of repetition to help students with a better understanding of the concepts listed above.