

## **ECE 445 Introduction to Control Systems**

### **Knowledge Probe – Fall 2008**

**Course Coordinator:** Rafael Fierro

**ABET Outcomes probed:** C, E

**Relevant pre- and co-requisite classes:** ECE 314

#### **1. Instruments**

Two knowledge probes were administered for the Fall 2008.

##### **a. KP(B)**

The first one given at the beginning of the semester KP(B) was meant to address **outcome C** (*ability to design a system, component, or process to meet desired needs*). In addition the probe was designed to evaluate if the students in ECE 445 had the background in signal and systems, basic circuits theory, differential equations. The probe was made as optional assignment. Students were instructed to answer each question to the best of their ability. Out of the 32 students registered for the class, 27 turned in the probe. The probe contained multiple choice questions classified into groups as follows: (i) signals (Laplace Transform, frequency response, convolution), (ii) circuits (filters), (iii) system response and complex variables. Although addressing **outcome C** at the beginning of the semester was not straightforward, the rationale behind this probe is that if one does not understand a basic concept, it will difficult to design a system to meet desired needs. For instance, how one can design a high  $Q$  filter, without understanding what  $Q$  is or represents.

##### **b. KP(E)**

The second probe given at the end of the semester KP(E) was meant to address **outcome E** (*ability to identify, formulate, and solve engineering problems*). The probe was made part of the final exam. The ECE 445 final exam consisted of 10 short questions intending to evaluate the basic understanding of control systems analysis tools. Four selected questions of from the final exam are use as KP(E). Out of the 32 students registered for the class, 31 took the final exam and turned in the probe. As mentioned, the probe contained four questions all of them require an ability to identify and solve engineering control problems.

All four KP(E) questions were meant to address **outcome E**. The knowledge necessary to answer these questions should have been gained in this course ECE 445. More specifically,

#### **Question 1**

This question was meant to determine if students have a basic knowledge of DC motors and be able to formulate the differential equations to model the system. *A priori*, I expected 70% of the students to answer this question correctly.

### **Question 2**

This question was meant to determine if students have a basic knowledge to determine the dynamic behavior of simple control system. *A priori*, I expected 90% of the students to answer this question correctly.

### **Question 3**

This question was meant to determine if students have a basic knowledge to analysis a control system using the frequency response method. *A priori*, I expected 85% of the students to answer this question correctly.

### **Question 4**

This question was meant to determine if students have a basic knowledge to analyze and design a stable system using the root-locus approach. *A priori*, I expected 90% of the students to answer this question correctly.

## **Results**

Thirty one students took the knowledge probe. The allotted time appears to be reasonable for all students to demonstrate their knowledge.

### **Question 1**

Nine students answered the question essentially correctly. Four others answered more than 70% correctly. Only 41% answered the question essentially correctly.

### **Question 2**

Twenty four students answered the question essentially correctly. Seven others answered more than 50% correctly. 77% answered the question essentially correctly.

### **Question 3**

Twenty students answered the question essentially correctly. Five others answered more than 70% correctly. 65% answered the question essentially correctly.

### **Question 4**

Twenty six students answered the question essentially correctly. Five others answered around 50% correctly. 84% answered the question essentially correctly.

## **2. Results**

Since ECE 445 requires two probes KP(B) and KP(E), the results for each are summarized above

in their respective sections. The analysis and follow-up, however, consider both probes simultaneously.

### **3. Analysis**

Considering the KP(B), I can state that the mathematical preparation and maturity of the students (e.g., complex numbers) showed some deficiencies. Several students in the class seemed to have trouble performing basic calculations with complex quantities, partial fraction expansion, and basic matrix operations. Also, this analysis is along the lines of ECE 314 which is pre-requisite for ECE 445. I also noticed some deficiencies in solving simple differential equations, applying Laplace transforms, formulating mesh and node equations when describing an electric circuit, and performing basic matrix operations.

Most students did reasonable well in the course as reflected in KP(E).

### **4. Suggested Actions and Follow-up**

Increased emphasis should be placed on understanding fundamentals and basic concepts, rather than “application of formulas” to straightforward problems. It would be desirable that students follow the curriculum established by the Department. For instance, it would be a good idea taking CE 304 before taking ECE 445. Also, it is advisable taking ECE 445 immediately after taking ECE 314. Several students mentioned that they took ECE 314 two years ago and forgot some of the fundamentals taught there.

Finally, ECE 445 should be more hands-on and experimentally oriented. Some efforts are being carried out in this direction. It is critical to implement a well-structured lab component as part of ECE 445 and the follow-up course ECE 446.