

KBOR DETAILED ASSESSMENT OF STUDENT LEARNING REPORT

GRADUATE CERTIFICATE PROGRAM REAL-TIME EMBEDDED SYSTEM DESIGN

I. Introduction

A) College, Department, and date.

College: Engineering
Department: Computing and Information Sciences
Date: April 3, 2009

B) Person(s) responsible for preparing the report.
Mitchell Neilsen

II. Overview of Assessment

A) Summary of the Department's/Program's ORIGINAL approved Assessment Plan, including a list of the original approved Student Learning Outcomes (SLOs) (Include a copy of the original Assessment Plan in *Appendix A*)

The original assessment plan involved evaluating the students against the following Student Learning Outcomes:

- *Master the core knowledge of real-time embedded system design*, through an interdisciplinary collection of courses in real-time system architectures and organization, real-time operating systems, real-time design methodologies, real-time scheduling theory, real-time verification, and application of the methodologies to individual and team problem-solving activities.
- *Develop skills for application of core knowledge*, by means of training in contemporary design-and-development methodologies and application of those methodologies to individual, interdisciplinary, and team problem-solving activities.

Faculty members teaching the core courses in the graduate certificate program are responsible for assessing the students. Data with respect to direct measures are collected by those instructors from exams administered in the course.

B) Summary of modifications made to the Assessment Plan during the previous four years.

Since the Assessment Plan has only been in place for a few years, no changes have been made to date.

C) List of the current SLOs for the Department/Program

Same as above.

D) Program Assessment Alignment Matrix (include a copy in *Appendix B*)

Relationship to K-State Student Learning Outcomes (insert the program SLOs and check all that apply):

Program SLOs	University-wide SLOs (Graduate Programs)			Program SLO is conceptually different from university SLOs
	Knowledge	Skills	Attitudes and Professional Conduct	
1. Core Knowledge	X	X		
2. Application		X	X	

- E) List the website where the Program SLOs, Assessment summary, and Alignment Matrix for each degree program are located (within two clicks of the Department/Program front page).

<http://www.cis.ksu.edu/files/grad-certificate.pdf>

III. Assessment Strategies

For each SLO, please describe:

- A) The measures used (approximately one-half of the measures used are to be direct measures, and at least one direct measure must be used for each student learning outcome) (Examples of direct measures can be accessed at <http://www.k-state.edu/assessment/plans/measures/direct.htm>).

The following measures were used for each SLO.

- **Direct Measure: Exams.** This measure will assess the results of selected questions from exams and projects given in the core embedded system design sequence; specifically, CIS 721 and EECE 733. All students in this Graduate Certificate Program are required to complete these courses. The specific questions for evaluation will be formulated by the course instructor in collaboration with the faculty members associated with the Graduate Certificate Program. Also, a rubric will be developed to assess student responses to these exam questions. Each instructor's assessment will be summarized in a spreadsheet with the number of students receiving each score on the question assessed, along with the instructor's analysis of the resulting data.
- **Direct Measure: Capstone Design Course.** The Capstone Design Course, EECE 733, involves team projects that encompass the complete real-time design methodology. These projects should be a good demonstration of a student's knowledge of real-time embedded system design. The instructor of EECE 733, in cooperation with the associated faculty members, will develop a rubric to assess each team and each individual on their understanding of core knowledge and practical design skills. The instructor's assessment will consist of a summary in a spreadsheet with the number of students receiving each score on the rubric, along with the instructor's analysis of the data. Since all students completing the Graduate Certificate Program are required to take the

Capstone Design Course, this assessment will encompass all students in the program.

- ***Indirect Measure: Post Program Survey.*** An exit survey that was developed for the NSF CRCD Program, supporting this curriculum development, will be adapted and used to identify student attitudes and perceptions, and information regarding plans after graduation. The survey will include questions that encompass both direct and indirect measures. Indirect feedback will also be sought from the Industry Advisory Boards that visit our departments each year, and through the Alumni Surveys that are completed by departmental alumni each year. This information will be compiled by the Program Coordinator for review and discussion by all faculty members involved in the graduate certificate program.

B) The timetable for the assessment strategies

The first core course to be evaluated was CIS 721, during the Spring 2007 semester, the next course was EECE 733, during the Spring 2008 semester.

C) A description of the method(s) in which the measures were administered.

In each exam, specific questions are identified together with acceptable levels of performance. The results from these exams are tabulated and analyzed. An example is shown in the Appendix. The results are then review by members of the Certificate Program.

IV. Assessment Results

Describe the results of the assessment strategies, including, but not limited to:

A) The specific quantitative and qualitative data collected during the review cycle

Quantitative data from exams was collected. In addition, since the program is completed in conjunction with a Master's Degree Program, the M.S. Evaluation Form required the supervisory committee members to rate each student on a scale from 1 to 5 on a set of six questions during their final defense. In case the communication skills were judged to be unacceptable, the evaluator had to indicate whether oral or written skills were an issue.

B) The sample of students from whom data were collected during review cycle

The data was collected for all students who graduated during this period.

C) Other results or outcomes from the assessment strategies.

The feedback forms results were as follows for each question.

- Question 1 (which directly assessed SLO1): 99% above acceptable or excellent.
- Question 2 (which directly assessed SLO2): 25% were rated as acceptable and 75% above acceptable or excellent.

- Question 3 (which indirectly assessed SLO1 and SLO2): 17% were rated as acceptable and 79% above acceptable or excellent.
- Question 4 (which indirectly assessed SLO1 and SLO2): 25% were rated as acceptable and 72% above acceptable or excellent.
- Question 5 (which indirectly assessed SLO1, SLO2 and SLO3): 13% were rated as acceptable and 83% above acceptable or excellent.
- Question 6 (which directly assessed SLO3): 13% were rated as acceptable and 85% above acceptable or excellent.
- For the Quantitative Exam Analysis, all students performed above the acceptable level.

V. Review of the Assessment Results

- A) Describe the process by which program faculty reviewed the results and decided on the actions and/or revisions that were indicated by those results.

The results obtained from the evaluation forms are reviewed by the Graduate Studies Committee and distributed to the CIS faculty, and compared with the previous results. The faculty discusses these results in a faculty meeting. Changes to the curriculum and/or changes to the expectations for graduate performance are discussed, documented and implemented.

VI. Actions and Revisions Implemented

- A) Describe the actions and/or revisions that were implemented in response to the assessment results and review of the results by faculty.

It was found that some of the students entering the M.S. program did not have adequate theoretical background. This problem was addressed by assigning courses in this area as required courses at the time of admission.

Students are required to complete at least one course in the Systems area. Two courses CIS 722 (Operating Systems Principles) and CIS726 (Advanced WWW Technologies) were added to the list of courses in this area.

VII. Effects on Student Learning and Future Plans

- A) Describe the effects on student learning of the actions and/or revisions that occurred during the review cycle.

The students have more choices of courses in both Fall and Spring semesters to satisfy the systems area requirement.

B) Describe the plans for the next ASL cycle. All changes to the ASL plan should be clearly justified relative to assessment results, data, and actions described in this report.

We plan to collect more data in the form of feedback from the students in evaluating the impact of the revisions made and also suggestions for potential revisions to the curriculum. At this point, we have a somewhat limited amount of data on which to base changes to the Graduate Certificate Program.

Appendix A: Original Approved Assessment Plan

Graduate Certificate Program in Real-Time Embedded System Design Assessment of Student Learning Plan

Kansas State University

- Check the box if your program's student learning outcomes have been modified since November 2003. If so, please email (apr@ksu.edu) or attach a hard copy to this document.

College, Department, and Date

College: *Engineering*
Department: *Computing and Information Sciences*
Date: *January 20, 2007*

Contact Person(s) for the Assessment Plans

Mitchell L. Neilsen, Graduate Certificate Program Coordinator

Degree Program

Graduate Certificate Program in Real-Time Embedded System Design

Assessment of Student Learning Three-Year Plan

Student Learning Outcome(s)

The Graduate Certificate Program in Real-Time Embedded System Design seeks to enable students to:

- *Master the core knowledge of real-time embedded system design, through an interdisciplinary collection of courses in real-time system architectures and organization, real-time operating systems, real-time design methodologies, real-time scheduling theory, real-time verification, and application of the methodologies to individual and team problem-solving activities.*
- *Develop skills for application of core knowledge, by means of training in contemporary design-and-development methodologies and application of those methodologies to individual, interdisciplinary, and team problem-solving activities.*

Special rationale for selecting these learning outcomes (optional):

[If applicable, provide a brief rationale for the learning outcomes that were selected]

Relationship to K-State Student Learning Outcomes (insert the program SLOs and check all that apply):

Program SLOs	University-wide SLOs (Graduate Programs)			Program SLO is conceptually different from university SLOs
	Knowledge	Skills	Attitudes and Professional Conduct	
1. Core Knowledge	X	X		
2. Application		X	X	

How will the learning outcomes be assessed? What groups will be included in the assessment?

- **Outcome:** *Master the core knowledge of real-time embedded system design*, through an interdisciplinary collection of courses in real-time system architectures and organization, real-time operating systems, real-time design methodologies, real-time scheduling theory, real-time verification, and application of the methodologies to individual and team problem-solving activities.
 - **Direct Measure: Exams.** This measure will assess the results of selected questions from exams and projects given in the core embedded system design sequence; specifically, CIS 721 and EECE 733. All students in this Graduate Certificate Program are required to complete these courses. The specific questions for evaluation will be formulated by the course instructor in collaboration with the faculty members associated with the Graduate Certificate Program. Also, a rubric will be developed to assess student responses to these exam questions. Each instructor’s assessment will be summarized in a spreadsheet with the number of students receiving each score on the question assessed, along with the instructor’s analysis of the resulting data.
 - **Direct Measure: Capstone Design Course.** The Capstone Design Course, EECE 733, involves team projects that encompass the complete real-time design methodology. These projects should be a good demonstration of a student’s knowledge of real-time embedded system design. The instructor of EECE 733, in cooperation with the associated faculty members, will develop a rubric to assess each team and each individual on their understanding of core knowledge and practical design skills. The instructor’s assessment will consist of a summary in a spreadsheet with the number of students receiving each score on the rubric, along with the instructor’s analysis of the data. Since all students completing the Graduate Certificate Program are required to take the Capstone Design Course, this assessment will encompass all students in the program.

- **Outcome:** *Develop skills for application of core knowledge*, by means of training in contemporary design-and-development methodologies and application of those methodologies to individual, interdisciplinary, and team problem-solving activities.
 - **Direct Measure: Exams.** This measure will assess the results of selected questions from exams and projects given in the core embedded system design sequence; specifically CIS 721 and EECE 733. All students in this Graduate Certificate Program are required to complete these courses. The specific questions for evaluation will be formulated by the course instructor in collaboration with the faculty members associated with the Graduate Certificate Program. Also, a rubric will be developed to assess student responses to these exam questions. Each instructor’s assessment will be summarized in a spreadsheet with the number of students receiving each score on the question assessed, along with the instructor’s analysis of the resulting data.

- **Direct Measure: Capstone Design Course.** The Capstone Design Course, EECE 733, involves team projects that encompass the complete real-time design methodology. These projects should be a good demonstration of a student's knowledge of real-time embedded system design. The instructor of EECE 733, in cooperation with the associated faculty members, will develop a rubric to assess each team and each individual on their understanding of core knowledge and practical design skills. The instructor's assessment will consist of a summary in a spreadsheet with the number of students receiving each score on the rubric, along with the instructor's analysis of the data. Since all students completing the Graduate Certificate Program are required to take the Capstone Design Course, this assessment will encompass all students in the program.
- **All Outcomes**
 - **Indirect Measure: Post Program Survey.** An exit survey that was developed for the NSF CRCD Program, supporting this curriculum development, will be adapted and used to identify student attitudes and perceptions, and information regarding plans after graduation. The survey will include questions that encompass both direct and indirect measures. Indirect feedback will also be sought from the Industry Advisory Boards that visit our departments each year, and through the Alumni Surveys that are completed by departmental alumni each year. This information will be compiled by the Program Coordinator for review and discussion by all faculty members involved in the graduate certificate program.

When will these outcomes be assessed? When and in what format will the results of the assessment be discussed?

- **Exam Question Assessment:** Specific exam questions will be assessed each time the course is offered. The instructor for the course will compile a summary in spreadsheet form and submit this summary to the Graduate Certificate Program Coordinator. Members of the committee will then review the summaries from all courses in the core sequence. In addition, they will consider if changes need to be made in the core sequence. Finally, feedback for improvement of the assessment mechanism will be incorporated into future assessments. The assessments will be phased in starting with the Spring 2007 Semester:
 - **Spring 2007:** CIS 721
 - **Spring 2008:** CIS 721 and EECE 733
- **Capstone Course Assessment:** Each year, starting with Spring 2008, the instructor of EECE 733 will submit a summary of the results of this assessment to the Graduate Certificate Program Committee. The committee will review the data with the data collected in previous years. A summary of the results will be forwarded onto faculty members involved in the program once a year. As necessary, feedback will be given to individual instructors regarding areas that need attention.
- **Post Program Surveys:** Each Spring, the Program Coordinator will submit a summary of the results of this assessment to the Graduate Program Committee. The committee will review the data with the data collected in previous years. A summary of the results will be forwarded onto faculty members involved in the program once a year. As necessary, feedback will be given to individual instructors regarding areas that need attention.

What is the unit's process for using assessment results to improve student learning?

[Briefly describe your process for using assessment data to improve student learning.]

When less than 90% of students fail to achieve a satisfactory level of performance on a specific student learning outcome in one of the three Core Courses, changes will be made to improve student performance. In addition, we plan to pay close attention to melding courses in the core sequence and determine if changes need to be made to the courses listed in the Selected Course List. To the extent possible, assessments of the courses in the Selected Course List will also be included in our evaluation.

In addition to assessing results each year, we also plan to assess longitudinal trends in performance.

Appendix B: Assessment Alignment Matrix (Examples can be accessed at <http://www.k-state.edu/assessment/plans/measures/index.htm>).

Relationship to K-State Student Learning Outcomes (insert the program SLOs and check all that apply):

Program SLOs	University-wide SLOs (Graduate Programs)			Program SLO is conceptually different from university SLOs
	Knowledge	Skills	Attitudes and Professional Conduct	
1. Core Knowledge	X	X		
2. Application		X	X	

Appendix C: Other relevant documents (data tables, measurement instruments, etc.)

CIS 721 Assessment

-- Question from Final Exam --

CIS 721 - Real-Time Systems

Final Exam – Question 1
Spring 2007

1. Consider a priority-based system consisting of three periodic tasks, A, B, and C, with the following properties:

Task	Run Time (C_i)	Period (T_i)	Deadline (D_i)
A	6	16	16
B	6	20	18
C	10	40	40

Suppose that tasks are assigned priorities using a rate monotonic priority assignment.

- (a) Can Liu and Layland's Utilization Based Test be used to determine if the task set is feasible? _____. Why or why not. (Note you do not need to actually apply the test).
- (b) Using Leung's Test, what is the minimum length of the interval that needs to be checked to determine if the task set is feasible? _____. Draw the Gantt Chart showing how the jobs in each task will be scheduled over this interval. Is the task set feasible based on Leung's Test?
- (c) Is the task set feasible based on Response Time Analysis? _____. Show work.

CIS 721 - Real-Time Systems

Final Exam – Model Solution – Question 1

Spring 2007

1. Consider a priority-based system consisting of three periodic tasks, A, B, and C, with the following properties:

Task	Run Time (C_i)	Period (T_i)	Deadline (D_i)
A	6	16	16
B	6	20	18
C	10	40	40

$$W_c^3 = W_c^0 + \sum_{j \in hp(i)} \left(\left\lceil \frac{W_c^2}{T_j} \right\rceil \times C_j \right) = 10 + \left\lceil \frac{34}{16} \right\rceil 6 + \left\lceil \frac{34}{20} \right\rceil 6 = 40$$

$$W_c^4 = W_c^0 + \sum_{j \in hp(i)} \left(\left\lceil \frac{W_c^3}{T_j} \right\rceil \times C_j \right) = 10 + \left\lceil \frac{40}{16} \right\rceil 6 + \left\lceil \frac{40}{20} \right\rceil 6 = 40$$

$$\Rightarrow R_c = 40 \leq D_c = 40;$$

∴ The task set is schedulable by using response time analysis.

Student Performance

Points Awarded (25 max)	Number of Students	Percent	Σ Percent	Exam Score (100 max)
25	24	63.2%	63.2%	97, 95, 95, 95, 95, 94, 93, 93, 91, 91, 90, 90, 90, 88, 88, 88, 88, 87, 85, 85, 84, 81, 80, 80, 74
24	0	0.0%	63.2%	
23	0	0.0%	63.2%	
22	0	0.0%	63.2%	
21	0	0.0%	63.2%	
20	12	31.6%	94.7%	95, 93, 90, 90, 90, 89, 88, 86, 82, 77, 75, 74
19	0	0.0%	94.7%	
18	0	0.0%	94.7%	
17	0	0.0%	94.7%	
16	0	0.0%	94.7%	
15	0	0.0%	94.7%	
14	0	0.0%	94.7%	
13	0	0.0%	94.7%	
12	0	0.0%	94.7%	
11	0	0.0%	94.7%	
10	0	0.0%	94.7%	
9	0	0.0%	94.7%	
8	0	0.0%	94.7%	
7	0	0.0%	94.7%	
6	0	0.0%	94.7%	
5	0	0.0%	94.7%	
4	0	0.0%	94.7%	
3	0	0.0%	94.7%	
2	0	0.0%	94.7%	
1	0	0.0%	94.7%	
0	2	5.3%	100.0%	

This question was used to test each student's understanding of feasibility analysis using both Utilization-based Analysis and Response Time Analysis. All students identified the task set as feasible based on Response Time Analysis, but some students incorrectly applied Liu and Layland's Test when it did not apply.

All students achieved a satisfactory level of performance (80% = 20/25)