Oregon Institute of Technology
Computer Systems Engineering Technology Department
Embedded Systems Engineering Technology Program Assessment
2009-10

I. Introduction

The Embedded Systems Engineering Technology (ESET) program was proposed to OUS in spring of 2006 and approved in August, 2006. The curriculum for the ESET program is common with the hardware and software programs for the freshman year. The sophomore year of the ESET program has been constructed to mirror the track through both the Computer Engineering Technology (CET) and Software Engineering Technology (CET) programs, called the Dual Degree program. The ESET program junior year is when ESET students get instruction specific to topics of embedded systems engineering. These courses were taught for the first time in fall, 2008.

II. Mission, Objectives and Program Student Learning Outcomes

The mission of the Embedded Systems Engineering Technology (ESET) bachelor's degree program within the Computer Systems Engineering Technology (CSET) Department at Oregon Institute of Technology is to prepare our students for productive careers in industry and government by providing an excellent education incorporating industry-relevant, applied laboratory-based instruction in both the theory and application of embedded systems engineering. Our focus is educating students to meet the growing workforce demand in Oregon and elsewhere for graduates prepared in both hardware and software aspects of embedded systems. Major components of the ESET program's mission in the CSET Department are:

I. To educate a new generation of Embedded Systems Engineering Technology students to meet current and future industrial challenges and emerging embedded systems engineering trends.

II. To promote a sense of scholarship, leadership, and professional service among our graduates.

III. To enable our students to create, develop, apply, and disseminate knowledge within the embedded systems development environment.

IV. To expose our students to cross-disciplinary educational programs.

V. To provide government and high tech industry employers with graduates in embedded systems engineering and related professions.

Program Educational Objectives

The Program Educational Objectives reflect those attributes a student of the ESET program will practice in professional endeavors.

A. Graduates of the embedded program are expected to understand societal impact of embedded systems and technological solutions.

B. Graduates of the embedded degree program are expected to do hardware/software co-design for embedded systems. Graduates will continue to develop skills in analysis, approach, optimization, and implementation of embedded systems.

C. Graduates of the embedded program are expected to obtain the knowledge, skills and capabilities necessary for immediate employment in embedded systems. Embedded systems is a profession increasingly driven by advances in technology; therefore graduates are expected to obtain the necessary life-long learning skills to enable them to be able to adapt to a changing environment.

D. Graduates of the embedded program are expected to develop a broad base of skills. These skills will prepare them for professional practice: 1) as embedded engineers, 2) participants in embedded development teams, and 3) as effective communicators within a multidisciplinary team.

E. Graduates of the embedded program are expected to acquire knowledge of management and marketing of embedded projects and products and to prepare for series production.

Program Student Learning Outcomes

Embedded Systems Engineering Technology baccalaureate graduates will be engaged in:

1. Application of mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems (Objectives C, D, E).

2. Application of project management techniques to embedded systems projects (Objectives C and D).

3. Application of knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology. (Objective D)

4. A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society. (Objective A)

5. Identification and synthesis of solutions for embedded systems problems. (Objective B, C)

6. Design, execution and evaluation of experiments on embedded platforms. (Objective C, D)

7. Analysis, design and testing of systems that include both hardware and software. (Objective B, D)

8. Documenting the experimental processes and to writing of satisfactory technical reports/papers. (Objective D, E)

9. Delivery of technical oral presentations and interacting with a presentation audience. (Objective D, E)

10. Recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry. (Objective C)

11. Working effectively, independently, and in multi-person teams. (Objective D)

12. Professional and ethical execution of responsibilities. (Objective A, D)

III. Three-Year Cycle for Assessment of Student Learning Outcomes

Assessment activities for the ESET program will begin Fall, 2008. Table 1 presents planned learning outcome assessment on a three year cycle. The number in the cells of the table corresponds to the ISLO defined for the OIT assessment cycle.

Table 1: Baccalaureate Outcome Assessment Timeline

#	Learning Outcomes	08-09	09-10	10-11	11-12	12-13	13-14
1	The ability to apply mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems.	**6**			**6**		
2	An ability to apply project management techniques to embedded systems projects.		**2, 3**			**2, 3**	
3	Knowledge of embedded systems engineering technology, along with some specialization in at least one area of computer systems engineering technology.			**5**			**5**

4	A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.		**3, 8**			**3, 8**	
5	The ability to identify and synthesize solutions for embedded system problems.			**4**			**4**
6	The ability to design, conduct and evaluate the results of experiments on embedded platforms.	**7**			**7**		
7	The ability to analyze, design and test systems that include both hardware and software.	**7**			**7**		
8	The ability to document experimental processes and to write satisfactory technical reports/papers.			**1**			**1**
9	The ability to make technical oral presentations and interact with an audience.			**1**			**1**
10	The recognition for and the motivation to further develop their knowledge and skills as embedded engineering advances occur in industry.			**5**			**5**
11	The ability to work effectively independently and in multi-person teams.		**2**			**2**	
12	An understanding of professional and ethical responsibility.		**3, 8**			**3, 8**	

To summarize, Table 2 shows the outcomes (identified by number only) that will be assessed for each of the next three years.

Table 2: Summary of Assessment Timeline

Academic Year	Outcomes
2008-09	1, 6, 7
2009-10	2, 4, 11, 12
2010-11	3, 5, 8, 9, 10

Outcomes to be assessed are listed below:

2. Application of project management techniques to embedded systems projects.
4. A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.
11. Working effectively, independently, and in multi-person teams.
12. Professional and ethical execution of responsibilities.

Target courses where the assessment tools were to be applied for the 2009-10 academic year are summarized in Table 3.

Table 3: 2009 – 2010 Summary Courses of Assessment Application

Outcome	Courses	Term
2	CST 412 – Senior Development Project I CST 432 – Senior Development Project III	Fall Spring
4	CST 422 – Senior Development Project II CST 456 – Embedded System Testing	Winter Spring
11	CST 372 – Embedded Software Design II CST 347 – Real-Time Operating Systems	Winter Spring
12	CST 455 – System on a Chip Design CST 466 – Embedded System Security	Fall Spring

IV. Summary of 2009-10 Assessment Activities

The following are the direct assessment activities that were accomplished during 2009 - 2010 academic year. Each activity is introduced with a description of the activity followed by a table that summarized the rubric criteria along with the rubric application results. Where available, the rubric used for assessment is shown in Appendix A.

PSLO #2

Application of project management techniques to embedded systems projects.

CST 412 – Senior Development Project: Fall 2009

The Senior Project is an individual project completed by each student in the program. Each project represents individual effort. The write up completed by the end of the term should contain an overview of the project to be completed as well as specific design criteria to be completed by the end of sequence. By the end of the first term, the student should have a good idea of the project they will be working on and how they will be scheduling their work for the remainder of the sequence.

Data Collection Date: December 9, 2009 Coordinator: James N. Long

Assessment Method: The final report for the project was collected at the end of the term. This report contains the project description, subsystem definitions, work breakdown, and dependency definitions. The report was read and each performance criteria was evaluated. Table 1 shows the results of the evaluation.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Defines overall problem context.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
2. Breaks problem down into subsystems and provides reasonable work load estimates.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
3. Describes subsystem dependencies.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
4. Reflects subsystems and dependencies in project schedule.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%

Table 1 – Assessment outcome results for CST 412 – *Senior Development Project*

Evaluation of results: The results of this assessment indicate students are well versed at decomposition of a large problem. They were able to define the problem boundaries, break the problem down into well defined subsystems and derive dependencies on those subsystems. The shortcoming is in creating a time based schedule for estimation of project work sequencing and work load scheduling.

Actions: The ESET Junior Project sequence needs to have a larger component targeted at project scheduling and work estimation. Project scheduling should be strongly introduced early in the first term of the three term sequence and then emphasized at least once in each subsequent term.

CST 432 – Senior Development Project: Spring 2010

The Senior Project is an individual project completed by each student in the program. Each project represents individual effort. The write up completed by the end of the year should contain an overview of the project to be completed as well as specific design criteria to be completed by the end of sequence. By the end of the year, the student should have completed the proposed project and have a good historical record of changes they made while developing the system. These changes should reflect in modified schedules and change reports related to the overall progress of the project.

Data Collection Date: June 1, 2010 Coordinator: James N. Long

Assessment Method: The student project logs were collected from the year of project development. These project logs contain project time line modifications as well as issue report that impact project completion. The logs were read and evaluated for the rubric shown in Table 2 below. In the logs, change correlation between issue reports and development time line/feature set was closely noted.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Defines overall problem context.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 1 100%
2. Breaks problem down into subsystems and provides reasonable work load estimates.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 1 100%

3. Describes subsystem dependencies.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 1 100%
4. Reflects subsystems and dependencies in project schedule.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 1 100%

Table 2 – Assessment outcome results for CST 432 – *Senior Development Project*

Evaluation of results: In this assessment, it was clear that students are good at changing action and project course depending on problems encountered in the project development cycle and the outcome of solving the encountered problem.

Actions: This assessment shows students have a good grasp of adapting project schedule to changing project needs by the end of the spring term in the Sr. Project sequence. As noted earlier, to get a strong understanding by the start of the Sr. year, project scheduling should be strongly introduced early in the first term of the three term Junior Project sequence and then emphasized at least once in each subsequent term.

PSLO #4

A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.

CST 422 – Senior Development Project: Winter 2010

The student Sr. Project reports were collected and evaluated against the Societal Impact rubric. In the project report, students are expected to build a business case in which they detail how their intended system will be used and what impacts this will have on groups of end users. Students are expected to look beyond traditional user groups to evaluate broader impacts of work they are performing.

Data Collection Date: 3/5/2010 Coordinator: James N. Long

Assessment Method: The project report was collected at the end of the term. This report contains several sections that outline a business case for the creation of the project. In these sections, the student describes system purpose, intended system users, system functional description, and impacts of system deployment as well as future considerations for the system operation. These areas of the report were read and evaluated against the societal impact performance criteria. Table 3 shows the results of this evaluation.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Defines and evaluates end users.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
2. Defines system behavior as related to defined users.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
3. Describes impacts of system operations on end user population.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
4. Extrapolates impacts to include groups beyond immediate users.	Sr. Project Report	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	0 of 2 0%

Table 3 – Assessment outcome results for CST 422 – Sr. Development Project II

Evaluation of results: The results of this assessment indicate that ESET students have a strong grasp on defining direct users of their system and operations their system are to perform. Their understanding of broader impacts of system creation and deployment is limited. After interviewing students involved in the assessment, it was clear that there was no understanding of broader impact analysis of system deployment as being a requirement of the deliverable used for assessment.

Actions: In the Sr. Project sequence, students need to be instructed on evaluation of the broader impacts of systems they are building and where in their project write up this analysis is to be included.

CST 456 – Embedded System Testing: Spring 2010

The embedded systems curriculum is currently being modified to accommodate a light student load. No assessment activities were run for the ESET program in the Embedded Systems Testing course in this assessment cycle.

PSLO #11

Working effectively, independently, and in multi-person teams.

CST 372 – Embedded Systems Development II: Winter 2010

The Embedded Systems Development II course is the second term in a three term team based project class. Student teams were observed throughout the term. During the term, the instructor noted different aspects of student team based behavior and related this to the eventual outcome of the project goals. The teams had both dual major students and embedded systems students in them. Only the embedded systems students were included in the final assessment results.

Data Collection Date: 3/1/2010 Coordinator: Phong Nguyen

Assessment Method: The OIT Teamwork Rubric was applied to the different project teams by the course instructor, taking into account observed team behavior and project outcome. Students also evaluated the performance of their own teams using the same rubric. Table 4 shows the results of this evaluation.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Identify and achieve goal/purpose.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
2. Assume roles and responsibilities as appropriate.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
3. Team/group members interact appropriately.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
4. Recognize and help reconcile differences among team/group members.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%

5. Team/group members share work appropriately.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
6. Develop strategies for effective action.	Student and Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%

Table 4 – Assessment outcome results for CST 372 – Embedded Systems Development II

Evaluation of results: Students performed well in the team work and project based activities. Since the sample space is small, results can be skewed heavily by a single individual. One student in the sample had trouble with motivation during this quarter. A correlation could not be made between this individual and the curriculum offered in the ESET degree.

Actions: No action required. More data must be gathered in the next assessment cycle.

CST 347 – Real-Time Operating Systems: Spring 2010

In the Real-Time Operating Systems course, students work on a team-based, directed, term length project. The project involves collaborating to build a real time kernel and prove its correct operation. Work is done both in lab and at home.

Data Collection Date: 5/27/2010 Coordinator: James N. Long

Assessment Method: The OIT Teamwork Rubric was applied to the different project teams by the course instructor, taking into account observed team behavior and project outcome. Teams were observed during lab sessions and questioned about system operation, team performance, and project outcome. Table 5 shows the results of this evaluation.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Identify and achieve goal/purpose.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
2. Assume roles and responsibilities as appropriate.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%

3. Team/group members interact appropriately.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
4. Recognize and help reconcile differences among team/group members.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
5. Team/group members share work appropriately.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%
6. Develop strategies for effective action.	Instructor based Observation	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	2 of 2 100%

Table 5 – Assessment outcome results for CST 347 – Real-Time Operating Systems

Evaluation of results: Students in this area perform well in the teamwork and project base activities. The sequencing of assessment activities had the same two students working on the same team assessed with the same team rubric. As with the previous assessment, the sample size and close timeline of assessment activities shows no deficiencies in the ESET curriculum related to this measure.

Actions: None at this time. This assessment will prove more informational when ESET student numbers increase and group work becomes more mixed among individuals.

PSLO #12

Professional and ethical execution of responsibilities.

CST 455 – System on a Chip Design: Fall 2009

Students were given a homework assignment dealing with ethical scenarios. The assignment was in two parts. The first part had the students choose three different statements from a professional code of ethics created by a professional society related to the student's field of study. The student was asked to explain each of the three chosen statements and provide an example of where the code statement would apply. In the second part of the assignment, the students were given a scenario from a professional work environment. The students were asked to apply the given code of ethics and explain an appropriate course of action.

Data Collection Date: December 9, 2009 Coordinator: Ralph Caresteia

Assessment Method: The assignment was given and collected. Each essay paper was read and evaluated based on the performance criteria shown below in Table 6.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Using code of ethics, describes ethical issue(s)	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
2. Describes parties involved and discusses their points of view.	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
3. Describes and analyzes possible/ alternative approaches	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
4. Chooses an approach and explains the benefits and risks.	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%

Table 6 – Assessment outcome results for CST 455 – System on a Chip Design

Evaluation of results: The sample size for this assessment is small so results are extremely skewed by lower performance of a single student. One outcome of this assessment is the correlation of the high performer with the taking of a 300 level course on ethics. The student that had taken the 300 level ethics course understood the code of ethics, had a good idea of how the code would apply to them personally, and was able to use the professional code of ethics to resolve the given ethical dilemma. The student that had not taken the course performed substandard. The taking of the 300 level ethics course clearly had an impact on the student's understanding of ethics in the workplace.

Actions: The ESET curriculum map should be modified to include the 300 level ethics as a requirement, not just an elective. This would greatly improve student understanding of ethical situations.

CST 466 – Embedded Systems Security: Spring 2010

Students were given a homework assignment dealing with a specific ethical scenario. The students were asked to apply a given code of ethics and explain an appropriate course of action for the scenario.

Data Collection Date: 5/15/2010 Coordinator: Phong Nguyen

Assessment Method: The assignment was given and collected. Each essay paper was read and evaluated based on the performance criteria shown below in Table 7.

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
1. Using code of ethics, describes ethical issue(s)	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
2. Describes parties involved and discusses their points of view.	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
3. Describes and analyzes possible/ alternative approaches	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%
4. Chooses an approach and explains the benefits and risks.	Homework Assignment	No Proficiency (1)/ Some Proficiency (2)/ Proficiency (3)/ High Proficiency (4)	Proficiency (3)	1 of 2 50%

Table 7 – Assessment outcome results for CST 466 – Embedded Systems Security

Evaluation of results: Once again, the sample space is very small so outcome of the assessment is suspect. This activity was given to the same two students as the fall assessment exercise with no additional course work on ethics, so it is not surprise that results are similar.

Actions: As mentioned earlier, requirements of a 300 level ethics course would bolster knowledge of ethics for students taking the ESET curriculum.

V. Summary of Student Learning

PSLO #2 - Application of project management techniques to embedded systems projects.

Evaluation of results: Students are good at project decomposition; however, there was a weakness in sequencing of task dependencies.

Actions: Early in the junior project sequence, task breakdown, sequencing, and dependencies needs to be emphasized. This should be revisited at least once a term as students work in their project throughout the year.

PSLO #4 - A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.

Evaluation of results: Students have a good grasp of direct users of their systems; however, they have trouble extrapolating beyond this direct end-user experience.

Actions: Students need to be instructed on creation of a business case for the systems they construct in the junior and senior project sequences. In the business, they should consider larger impacts of their system.

PSLO #11 – Working effectively, independently, and in multi-person teams.

Evaluation of results: The results were inconclusive due to the small sample space being applied to a team.

Actions: More data must be collected as the program gains more students.

PSLO #12 – Professional and ethical execution of responsibilities.

Evaluation of results: Assessment shows a lack of understanding of ethics related to professional activities when students are not engaged in a 300 level course on ethics.

Actions: The ESET curriculum needs to be modified so a 300 level ethics related course is required.

VI. Changes Resulting from Assessment

At the end of the 2008-2009 assessment cycle, the following action items were noted:

PSLO #1 - The ability to apply mathematics including differential and integral calculus, probability, and discrete mathematics to hardware and software problems.

Action Items: We need to emphasize the use of graphical representations of data for use in solving engineering problems. This should be done in both CST 162 and CST 315. This will be re-assessed in CST 315, Fall 2009.

PSLO #7 – The ability to analyze, design and test systems that include both hardware and software.

Action Items: Instructor will develop additional lectures on test bench code and code coverage, and will develop demonstrations on how execution of test bench code produces valid simulation test with appropriate coverage. This the first time the course has been offered. Assessment on modifications will be performed in the next assessment cycle.

Evaluation of these changes had not yet been performed.

Appendix A – Assessment Rubrics

PSLO #2

Application of project management techniques to embedded systems projects.

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)	Score
1. Defines overall problem context.	Has a vague idea of what the problem boundaries are and is uncertain what functions are required of a completed system.	Gives project boundaries and a definition of internal and external entities.	Describes the problem for purpose of a defined end point.	Describes problem is a concise statement. Shows a clear understanding of system actors.	
2. Breaks problem down into subsystems and provides reasonable work load estimates.	Gives little indication that system has been decomposed and no workload has been estimated for subsystem completion.	Shows a basic understanding of system decomposition but displays no application to proposed problem.	Subsystem description is given but responsibilities are vague. Estimates are not given.	Describes subsystems and their intended functional responsibilities. Gives rough estimates for effort of subsystem completion.	
3. Describes subsystem dependencies.	Shows no understanding of subsystems and what dependencies are described between defined subsystems.	Shows a basic understanding of system dependencies but does not apply this to current project.	Subsystem dependencies are alluded to but no concrete definitions are either modeled or articulated.	Describes dependencies between subsystems. Supports dependencies in statements derived through sound analysis.	
4. Reflects subsystems and dependencies in project schedule.	Does not show understanding of development scheduling based on management of development effort.	Gives a schedule but this schedule does not map to project subsystem construction.	Gives an idea of project scheduling showing a good chart of system construction. Does not show a firm grasp on deployment dependencies.	Produces a feasible schedule for system creation and deployment taking subsystem creation and dependency into account.	

PSLO #4

A broad education and knowledge of contemporary issues necessary to reason about the impact of embedded system based solutions to situations arising in society.

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)	Score
1. Defines and evaluates end users.	Shows no understanding of who the direct users of the system will be.	Shows a basic idea of end users with limited discussion on their motivation for use of the system.	Shows detailed knowledge of individual user types and a good understanding of user motivation for use of the system.	Describes populations of users, describes their interest in the system, and provides a generalized view of the population from which end users are derived.	
2. Defines system behavior as related to defined users.	Shows little or no grasp on specifics related to what the defined system will do.	Shows a general understanding of system behavior and how users will interact with the system. Indirect outcome of system operation is unclear.	Describes detailed system behavior, detailed user interaction, and direct effect of system operation on individual users.	Discusses system functional behavior as desired by the direct user population, system use as desired by the direct user population, and the outcome of system operation as directed at the direct user population.	
3. Describes impacts of system operations on end user population.	Shows limited or no understanding of how the end system will be used by the target user population or what impacts it will have on them as a group.	Discusses immediate benefits of the system to the end user population.	Describes direct and indirect benefits of the system to individual users of the system	Discusses system operations, how they may be used by the end user population, and the ramifications of proper and improper use in the direct user population.	
4. Extrapolates impacts to include groups beyond immediate users.	Has no extrapolation or relevant information related to larger impacts of the designed system at a societal level.	Shows limited understanding related to system use and place at a societal level.	Shows a good understanding of system scope, operation, and effects on a societal population.	Discusses ramifications of system operation beyond the immediate scope of the target system installation. Considers far reaching effects on the general population. Extrapolates future effects and potential use.	

PSLO #11

Working effectively, independently, and in multi-person teams.

OIT Team and Group Work Rubric, p. 1				
Performance Criteria	**No/Limited Proficiency (1)**	**Some Proficiency (2)**	**Proficiency (3)**	**High Proficiency (4)**
Identify and achieve goal/purpose	Clear goals are not formulated or documented; thus all members don't accept or understand the purpose/task of the group. Group does not achieve goal.	Individuals share some goals but a common purpose may be lacking. Priorities may be unrealistic and documentation may be incomplete. Group may not achieve goal.	Group shares common goals and purpose. Some priorities may be unrealistic or undocumented. Group achieves goal.	When appropriate, realistic, prioritized and measurable goals are agreed upon and documented and all team members share the common objectives/purpose. Team achieves goal.
Assume Roles and Responsibilities	Members do not fulfill roles and responsibilities. Leadership roles are not defined and/or shared. Members are not self-motivated and assignments are not completed on time. Many members miss meetings	Some members may not fulfill roles and responsibilities. Leadership roles are not clearly defined and/or effectively shared. Some members are not motivated and some assignments are not completed in a timely manner. Meetings rarely include most members.	Members often fulfill roles and responsibilities. Leadership roles are generally defined and/or shared. Generally, members are motivated and complete assignments in a timely manner. Many members attend most meetings.	Members consistently and effectively fulfill roles and responsibilities. Leadership roles are clearly defined and/or shared. Members move team toward the goal by giving and seeking information or opinions, and assessing ideas and arguments critically. Members are all self-motivated and complete assignments on time. Most members attend all meetings.
Interact Appropriately	Members do not communicate openly and respectfully. Members do not listen to each other. Communication patterns foster a negative climate that undermines teamwork and contributes to a lack of trust and low morale. Humor used is not appropriate.	Members may not consistently communicate openly and respectfully. Members may not listen to each other. Humor used may not be appropriate at times.	Members usually communicate openly and respectfully. Members often listen to most ideas. Members usually support and encourage each other. Humor used is generally appropriate.	Members always communicate openly and respectfully. Members listen to each other's ideas. Members support and encourage each other. Communication patterns foster a positive climate that motivates the team and builds cohesion and trust. Humor used is always appropriate and motivating.

PSLO #12

Professional and ethical execution of responsibilities.

Performance Criteria	Limited or No Proficiency (1)	Some Proficiency (2)	Proficiency (3)	High Proficiency (4)	Score
1. Using code of ethics, describes ethical issue(s)	Has a vague idea of what the issue is and is uncertain how the code of ethics applies.	Describes the issue(s) using concepts from code of ethics, but important elements may be missing or misunderstood.	Describes the issue(s) using basic concepts from code of ethics.	Describes the issue(s) in detail, demonstrating full understanding of relevant code of ethics provisions and how they relate to the issue(s).	
2. Describes parties involved and discusses their points of view.	Is unsure who should be involved in the issue and/or does not reflect on their viewpoints.	Describes some of the parties and their viewpoints, but important elements are missing or misunderstood.	Describes who should be involved in the issue(s) and discusses the viewpoints of the parties at a basic level.	Describes who should be involved in the issue(s) and thoroughly discusses their viewpoints.	
3. Describes and analyzes possible/ alternative approaches	Is unable to describe or analyze alternatives or consider the effect on parties involved.	Describes and analyzes only one alternative and its effect on parties involved, but important elements are missing or misunderstood.	Describes and analyzes at least two alternatives and their effects on parties involved.	Describes and analyzes a number of alternative approaches and thoroughly considers the interests and concerns of all parties involved.	
4. Chooses an approach and explains the benefits and risks.	Has difficulty choosing an approach or stating benefits and risks.	Chooses an approach and explains benefits and risks, but important elements are missing or misunderstood.	Chooses an approach and explains basic benefits and risks.	Chooses an approach and thoughtfully and thoroughly explains benefits and risks.	