Criterion 3. Program Outcomes

3.1 Outcomes of the Computer Engineering Program

After review of the ABET Criteria and the program objectives, it has been decided by the Computer engineering faculty that the ABET Criteria (3a-3k) encompass the spirit of our educational vision. Therefore, the outcomes (3a-3k) are adopted as the Computer Engineering Program Outcomes in addition to three additional outcomes as recommended by ABET for Computer engineering programs.

The Compute Engineering Program Outcomes are:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs

(d) an ability to function on multi-disciplinary teams

Our interpretation of multidisciplinary teams includes teams of individuals with similar educational backgrounds focusing on different aspects of a project as well as teams of individuals with different educational backgrounds.

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

Our interpretation of this includes teaching students that the underlying theory is important because the technology will change, coupled with enhancing their self-learning ability.

(j) knowledge of contemporary issues

Our interpretation of this includes presenting students with issues such as the impact of globalization, the outsourcing of both engineering and other support jobs as practiced by modern international companies.

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

(l) knowledge of probability and statistics and their applications in Computer engineering

(m) knowledge of discrete Mathematics

(n) the ability to design a system that involves the integration of hardware and software components

It should be noted that outcomes (l) and (m) were added to the program outcomes as knowledge of probability and statistics and knowledge of discrete mathematics are considered important for Computer engineers and they were added as was recommended by ABET for Computer engineering programs. Outcome (n) was added to the program outcomes in order to emphasize in our program integration aspects between hardware and software components in the design process. This is different from outcome (c) which focuses on design aspects in general, which may not include the integration of both hardware and software components.

3.2 Relation of Program Outcomes and Educational Objectives

The Computer engineering program educational objectives are served by the program outcomes. The relationship illustrating the program outcomes serving each objective is mapped in Table I given below. Below we describe the relation between Program Educational Objectives and Program Outcomes in more detail.

Objective 1: Practice profession with confidence and global competitiveness and make intellectual contributions to it

In order for Computer engineering students to be able to practice their profession with confidence and global competitiveness, students must have the basic and fundamental knowledge of mathematics, science and engineering and they should be able to apply it in formulating and solving Computer engineering problems. They should be able to design the required experimental setup and know how to interpret the collected data to help them analyze the problem they are facing and lead them to effective solutions. The students must have the required skills and experience with modern tools to enable them to perform the targeted tasks. Computer engineering profession often involves design aspects that need to meet specific targets like cost, speed, power, etc. They are also often based on teamwork that demands good experience on how to work effectively within a team to maintain global competitiveness. Thus, our program focuses on enhancing our students design abilities by integrating design aspects in many courses and includes system design issues that focus on integration of hardware and system components, which is a common practice nowadays in Computer systems design. In addition, teamwork is encouraged throughout the program in lab work and in all course projects and senior design project. A necessary aspect of successful engineers is their abilities to communicate their ideas effectively in presenting their work or in sharing information with other team members. This is one of the important outcomes addressed by our program. Preparing the students in all these aspects will give them the confidence to practice the Computer engineering profession and be able to make contributions to it.

Objective 2: Pursue a life-long career of personal and professional growth with superior work ethics and character

The Computer engineering field is one of the fields that are growing rapidly. This puts a requirement on engineers to develop their knowledge and skills to remain up to date and to grow in their profession. Thus, it is important to train the students on how to acquire knowledge and be able to learn it. Ability to engage in life-long learning is an important aspect of our program as often Computer engineers have to learn a new programming language or to learn the use of a new engineering tool. In order for our students to be able to grow professionally in their career, they must be trained to practice their profession with

Table I. Program outcomes related to program educational objectives.

Program Educational Objectives	Program Outcomes
1. Practice profession with confidence and global competitiveness and make intellectual contributions to it	a, b, c, d, e, g, k, l, m , n
2. Pursue a life-long career of personal and professional growth with superior work ethics and character	f, i, h, j
3. Pursue advanced study and research at the graduate level	a, b, e, g, i, k

superior work ethics and character. In addition, they must be aware of the impact of engineering solutions in global and societal context and be aware of contemporary issues affecting their economy and career.

Objective 3: Pursue advanced study and research at the graduate level

This objective is aligned with one of the university objectives in preparing our students for pursuing advanced study and research at the graduate level. For students to be well-prepared for pursuing graduate studies, they must have the necessary foundation in mathematics, science and engineering to formulate and solve research problems. They should be skillful at using necessary tools to allow them to perform necessary experiments to evaluate their proposed solutions. In addition, they must have excellent self-learning ability, as graduate studies and research require reading and understanding other published work. Excellent writing skills are an important aspect of graduate studies to help the student in his Thesis write-up and in publishing his research work.

3.3 Program Outcomes Coverage in Curriculum

In order to guarantee that the outcomes of the Computer engineering program will be achieved by students by the end of the program, it is necessary that these outcomes be injected and be well covered throughout the program curriculum. We have decided that the program outcomes should be covered by core courses in the program as core courses are taken by all students in the program. Elective courses are not considered as they are not guaranteed to be taken by all students. However, elective courses will provide additional enhancement for the achievement of the program outcomes. Each program outcome is addressed by a set of core courses in the program increasing the likelihood of its achievement by the end of the program.

The learning outcomes of each core course are mapped to the Program Outcomes with a level of emphasis being either low (L), medium (M), or High (H). The level of emphasis is related to the weight used for assessing an outcome in each course. For each core course, faculty members have agreed on a minimum weight that should be used in the assessment of each course outcome. This minimum weight guarantees a minimum level of coverage for an outcome in a course and is used for deciding the level of coverage for the program outcome corresponding to the course outcome.

The level of emphasis for an outcome is determined based on the weight as follows:

- When the course outcome weight is < 10%, it will be given a Low rank (L).
- When the course outcome weight is between 10% and 20% it will be given a Medium rank (M).
- When the course outcome weight is ≥ 20% it will be given a High rank (H).

Table II shows the mapping between Course Outcomes and Program Outcomes. The program outcomes are covered in an overlapping manner over the program's curriculum core courses. Design capabilities are well covered in several courses. The ability to apply knowledge of math, science and engineering to solve engineering problems are also well addressed in several courses. Teamwork is encouraged in all courses with lab work and/or project. Ability to design and conduct experiments is covered in courses involving lab work

and other related courses. The use of engineering tools is also emphasized in all courses with lab work and those having a course project. Students are also trained on self learning abilities in several courses. Communication skills are emphasized in all courses with a project in addition to the seminar course, coop and summer training. The seminar course (COE 390) is focused on enhancing students' oral presentation skills. In addition, a focused course on technical report writing (ENGL 214) is taken by all students and is focused on enhancing their writing skills. A dedicated course (IAS 211) that educates students on ethical issues and professional ethics is taken by all students. In addition, computing ethics aspects are covered in the seminar course (COE 390). Impact of engineering solutions on global and societal context is addressed in the seminar course (COE 390) and in the senior design project. Knowledge of contemporary issues are also addressed in the seminar course (COE 390), the senior design project and in other courses taken by the students from Islamic department.

Detailed course outcomes and their mapping to program outcomes are shown in Appendix I.

Table II. Coverage of Program Outcomes by core COE courses.

Outcome\ Course	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
COE 202	H		H								L			
COE 203		M	H	L			L				H			
COE 205			H	L					L		L			
COE 305	M	L	H	L	H				L		L			
COE 308	H		H		L				L		L			
COE 341	M		H		H				L		L			
COE 344	M	L			H					L	L			
COE 360	L	L	H	L			L				M			
COE 390						M	H	L	M	M				
COE 400	M	M		M	L		M		L		L			H
COE 485	L	M	H	M	L	L	M	L	L	L	M			
COE 351			H	M		M	H		M		M			
COE 399				M		M	H		M		H			
STAT 319												H		
ICS 252													H	
IAS 211						H								
ENGL 214							H							

3.4 Program Outcomes Assessment Process

One of the important aspects considered in developing the assessment process is to design a process that will help in making effective program improvements while being efficient and maintainable. The proposed assessment process is shown in Figure 1 and is based on the following key steps:

1. Once the Program Educational Objectives are derived based on input of all program constituents, Program Outcomes are revised and updated to cover the Program Educational Objectives.
2. Based on the Program Outcomes, it is decided in which course each outcome will be covered and the level of emphasis of an outcome as has been described in the previous section. In this step, it will be ensured that all program outcomes are well addressed and covered in the curriculum through mainly the core courses of the program.
3. Course outcomes will be assessed both directly and indirectly by course instructors and each instructor indicates based on his assessment of course outcomes whether the outcomes are achieved or they need improvement. In case an outcome needs improvement, the faculty member provides suggestions for improving the coverage of that outcome the next offering of the course.
4. Then, for each program outcome, a set of assessment methods are determined that will be used for assessing this outcome. In addition, a performance criteria will be set to determine whether the program outcome is considered met or not. This is based on developing rubrics that are used to assess and evaluate an outcome. The program outcomes assessment is decided to be independent of the course assessment and grading process and it is mainly based on a set of high level courses, a set of surveys and a COE Exit Exam. The following set of courses and surveys in addition to COE Exit Exam and Industry Advisory Board input are used in the assessment of program outcomes:

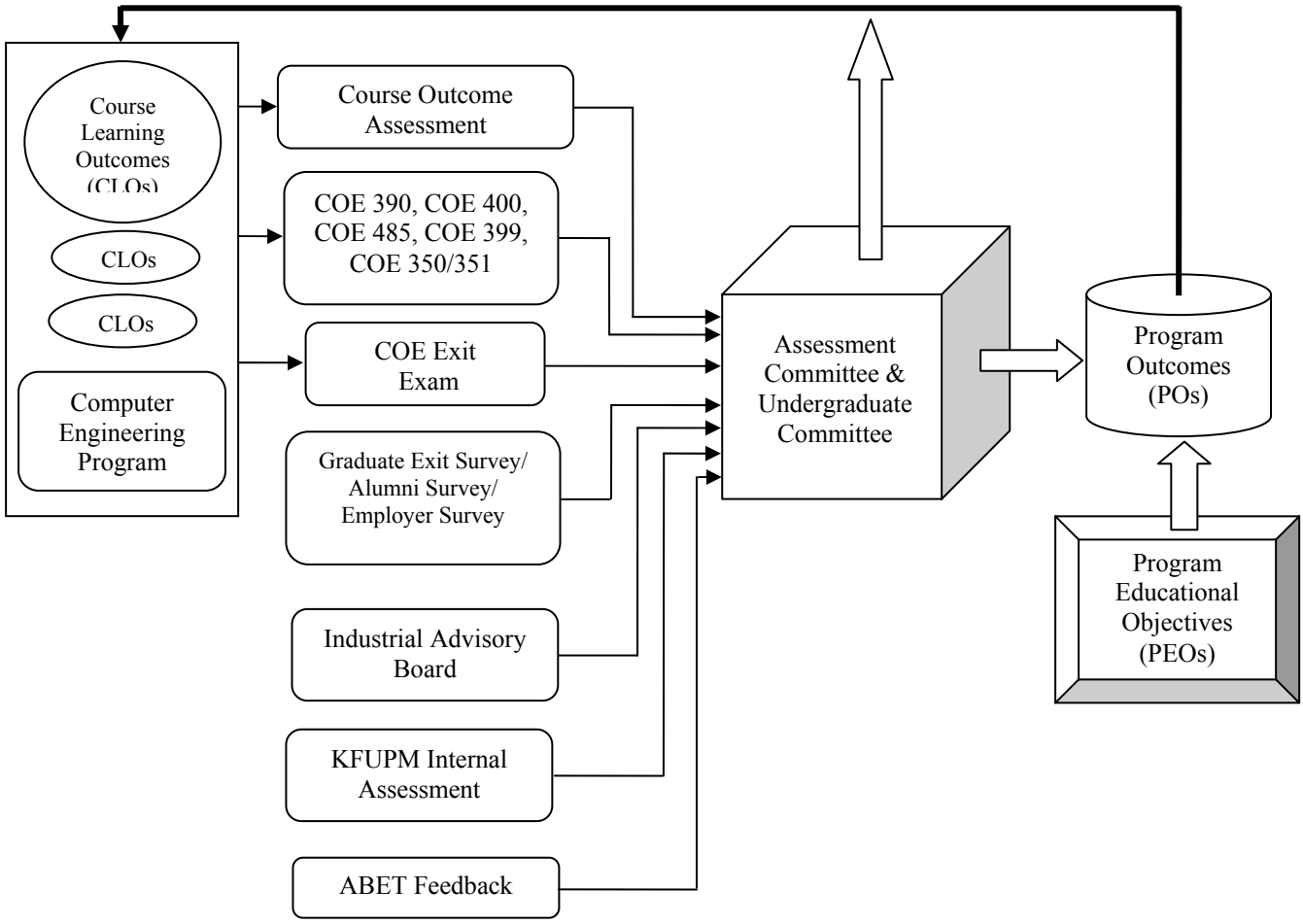

Figure 1 Program outcomes assessment process.

- COE 390: Seminar
- COE 400: System Design Lab
- COE 485: Senior Design Project
- COE 350/351: Co-Operative Work
- COE 399: COE Summer Training
- Graduate Exit Survey
- Alumni Survey
- Employer Survey

- COE Exit Exam
- Industrial Advisory Board input

More details will be given later in this section on the assessment of program outcomes and the assessment methods used.

The department has formed two committees to take care of the assessment process, the assessment committee and the undergraduate committee. The assessment committee is responsible for the design and control of the direct and indirect assessment processes, data collection and presentation, and the data delivery to the undergraduate committee.

The Assessment Committee has the following two tasks:

1. Design the ***indirect*** assessment tools and plan and schedule the indirect assessment process. This involves the following subtasks:

(i) Design web-based indirect assessment tools such as surveys for course outcomes, graduating students, Alumni, employer, and Advisory board, etc.

(ii) Set up a plan and a schedule for carrying out all indirect assessment.

(iii) Supervise the assessment process according to the plan and time, and generate statistical distribution in the form of graphical output for each tool-question to be delivered to the Undergraduate Committee.

2. Design the ***direct*** assessment tools and supervise the direct assessment process. This involves the following subtasks:

(i) Design web-based direct assessment tools such as evaluation forms for faculty course teaching, exit exam, course project, oral presentation, lab report, project report, capstone report, teamwork, etc.

(ii) Schedule and coordinate the exit exam and its grading.

(iii) Provide guidelines for the Faculty on how to use the web-based evaluation forms and corresponding data collection.

(iv) Supervise the assessment process according to the plan and time, and generate statistical distribution in the form of graphical output for each tool-question to be delivered to the Undergraduate Committee.

The Undergraduate Committee (UC), in addition to its current duties, is responsible of the following task:

(i) Carrying out analysis of direct and indirect assessment data provided by the Assessment Committee and the Faculty based on course assessment results.

(ii) Based on analyses of assessment data, identify potential problems and suggest recommendations for making improvements. This may include more emphasis on outcome coverage in courses or recommendations for curriculum revisions.

(iii) Implementing approved recommendations.

6. The university performs internal assessment of the Computer Engineering program every three years. Also, ABET assesses the program every six years. Comments received through this assessment process will be taken into account in revising Program Outcomes and covering them in courses.

Next, we will cover the assessment methods used in more detail in the following subsections.

3.4.1 Course Outcomes Assessment

For each course in the Computer engineering major, faculty involved in teaching the course have prepared a **Course Learning Outcomes Table** that includes the following for each outcome:

- **Outcome indicators and details**: this describes the main course topics that will be focused on to achieve the outcome.
- Suggested assessment methods and metrics.

- **Outcome minimum weight**: this indicates the importance of the outcome in the course. It is the minimum weight from the total course score (out of 100) that must be used for assessing the outcome or covering the outcome in the course.
- A mapping between the course learning outcome and ABET program outcomes.
- Each outcome is given a rank as **Low, High, Medium** that correlates with the weight used for assessing the outcome. This weight will be used in the final mapping table between courses and ABET program outcomes.
    - When the course outcome weight is < 10%, it will be given a Low rank (L).
    - When the course outcome weight is between 10% and 20% it will be given a Medium rank (M).
    - When the course outcome weight is ≥ 20% it will be given a High rank (H).

Course learning outcomes tables for all core Computer engineering courses are given in Appendix I.

Course outcomes are assessed every semester by course instructors both directly and indirectly. One suggested way to report the direct assessment of course learning outcomes is based on using **Course Learning Outcomes Evaluation Table** that includes the following for each outcome:

- **Outcome minimum weight**: this indicates the importance of the outcome in the course. It is the minimum weight from the total course score (out of 100) that must be used for assessing the outcome or covering the outcome in the course.
- **Outcome weight**: this is to be filled by the instructor indicating how much weight was used by the instructor for assessing the outcome.
- **Assessment Method**: this describes what methods were used to asses the outcome, the weight of each method, and the evidence of assessment.
- **Class Average:** indicates the student's average performance in the outcome.

It should be noted that the evaluation criteria for each outcome is flexible and can vary from an instructor to an instructor. However, it should be constrained with the minimum weight specified.

An example of course learning outcomes evaluation table is given in Table III.

Table III. Course learning outcomes evaluation table example.

COE 205 Computer Organization and Assembly Language Programming

Outcome	Outcome Min. Weight	Assessment Method								
		Assignments	**Quizzes**	**Exam I**	**Exam II**	**Exam III**	**Final Exam**	**Lab Work**	**Project**	**Total**
O1	**55%**	**15%**	**8%**	**15%**	**20%**			**5%**	**8%**	**71%**
	Average	12.1%	5.3%	9.5%	12.1%			4.1%	7%	50.1%(70.6%)
	Evidence	#1-4	#1-4, 6	Q1-5	Q1-5			#1-13	Report	
O2	**4%**							**5%**		**5%**
	Average							4.1%		4.1% (82%)
	Evidence							#1-13		
O3	**15%**						**20%**			**20%**
	Average						11.8%			11.8% (59%)
	Evidence						Q1-5			
O4	**2%**		**2%**							**2%**
	Average		1.3%							1.3% (65%)
	Evidence		#5							
O5	**2%**								**2%**	**2%**
	Average								1%	1% (50%)
	Evidence								Report	
Weight		**15%**	**10%**	**15%**	**20%**		**20%**	**10%**	**10%**	**100%**
Average		**12.1%**	**6.6%**	**9.5%**	**12.1%**		**11.8%**	**8.2%**	**8%**	**68.3%**

Class average for an outcome is computed by adding the average weights obtained from each assessment method used for the outcome divided by the total outcome weight. An example is shown below:

Class Average of Outcome 1 = [Assignments (12.1) + Quizzes (5.3) + Exam I (9.5) + Exam II (12.1) + Lab Work (4.1) + Project (7)] / 71 * 100 = 50.1/71*100 = 70.6.

Faculty may use the proposed outcome evaluation table or other methods to report the assessment of course learning outcomes. The important component in the direct assessment process is that each faculty must address the following important points for each outcome:

- Whether a course outcome is considered achieved with satisfactory level or not and provide justification for that.
- If an outcome needs improvements, suggest possible actions for improvement in the next offering of the course.

Course outcomes are also assessed indirectly through the use of a questionnaire in the last week of the semester. In this questionnaire, students are asked to evaluate their course outcome achievement in the course. An example of indirect outcome assessment form is given in Table IV. The achievement of each course outcome is rated as either Excellent (E), Good (G), Average (A), or Poor (P). A composite value is computed for each outcome out of 4. If the composite value of any outcome is < **2.5**, the instructor needs to comment on this and suggest corrective actions for improvement.

Table IV. Course learning outcomes indirect assessment form example.

COE 205 - Computer Organization & Assembly Language Course Outcomes Assessment						
Instructor:			**Term:**			
	Student Evaluation					
Criteria	**E (4)**	**G (3)**	**A (2)**	**P (1)**	**NA (0)**	**Composite**
1. As a result of this course, my ability to analyze, design, implement, and test assembly language programs can be described as,	11	6	2			3.47
2. As a result of this course, my ability to use tools and skills in analyzing and debugging assembly language programs can be described as,	6	10	3			3.16
3. As a result of this course, my ability to design the datapath and control unit of a simple CPU can be described as,	8	8	1	1	1	3.11
4. As a result of this course, my ability to demonstrate self-learning capability can be described as,	9	7	2	1		3.26
5. As a result of this course, my ability to work in a team can be described as,	8	7	4			3.21
	Number of Responses: 19					

The Undergraduate committee will review and evaluate the course assessment results every semester within the first two weeks of the beginning of a semester. Then, a report will be generated summarizing the findings and suggesting recommendations for addressing outcomes who achievement found need improvement to the department. The findings and suggested recommendations will be sent to all faculty members and discussions will be held in a department council. Once recommendations are approved, they are implemented by concerned faculty in related courses.

3.4.2 Program Outcomes Assessment

In this section, we describe how each program outcome is assessed. For each program outcome, an assessment and evaluation plan is developed that contains the following elements:

1. ***Assessment and Evaluation Methods:*** This describes what assessment methods are used to collect data and how will the data be evaluated and interpreted.
2. ***Performance Criteria:*** This determines the criteria used to indicate that an outcome has been achieved with satisfactory levels or needs improvement.
3. ***Logistics:*** This indicates when the data will be collected and who will collect it, interpret it, and report the results.

Before we describe the assessment and evaluation plan for program outcomes, we briefly describe the assessment methods used in the assessment of program outcomes.

(i) ***Industrial Advisory Board*****:**

The industrial advisory board consists of members from industrial organizations, which hire a good percentage of our graduates. The industrial advisory board will be asked to provide their input on the program learning outcomes and how they are covered in the courses. They will also be asked to provide feedback on the achievement of program outcomes by our graduates and which outcomes need to be improved through the program. Whenever possible, they will also be asked to evaluate some of students' work especially the senior design project and co-operative work, through which many of the program outcomes can be assessed. Meetings with the industrial advisory board will be arranged once every semester or once every year at the latest.

(ii) ***Employer Survey*****:**

Our students take either a six-week summer training program or a twenty-eight week co-operative work program. During these activities, a faculty member and a company supervisor supervise the students. Company supervisors are asked to

evaluate the performance of the students during these activities. We will use employer survey to ask employers to assess the program outcomes achievement by the students. In addition, employer surveys will be sent to companies who hire our graduate students.

Surveys for summer training program will be conducted yearly while surveys for co-operative program will be conducted every semester as students join the co-operative program every semester. Additional employer surveys will be conducted yearly.

(iii) ***Graduate Exit Survey*:**

The graduate exit survey will be conducted every semester asking Computer-engineering graduates to assess their ability in achieving each of the program outcomes and provide feedback on which outcome they think needs improvement and more emphasis in the program.

(iv) ***Computer Engineering Exit Exam*:**

The computer engineering exit exam is designed based on the core Computer engineering courses in which all the program outcomes are covered. This includes the courses: COE 202, COE 205, COE 305, COE 308, COE 341, COE 344, COE 360, and COE 400. The exam characteristics are as follows:

- 60 questions (multiple choice format) in total
- Two hours exam setting
- Each question should take an average of 2 minutes to answer
- Each question should map into one of the outcomes (a through n) claimed by the course.

The COE exit exam will be focused on fundamentals and will provide a good feedback in identifying some areas of improvements in the program.

The COE exit exam will be conducted every semester and all graduating students will be encouraged to take it. Students will be given certificates by the department

declaring that they have passed the COE exit exam. Students who pass the exam with distinction will have that indicated in their certificates and highest exam achievers will be given rewards by the department. This will encourage the students to take the exam and will help in providing a proper feedback.

(v) ***Seminar Course (COE 390)*****:**

This course will be used in the program outcomes assessment as it addresses some of the program outcomes with more emphasis than other courses. In this course, effective presentation skills are covered and students are given the chance to give two presentations. In the first presentation, students will be coached on the areas that need improvement and will receive feedback from both the instructor and other students based on the use of oral presentation assessment rubric. The second presentation has a high weight in the course and the presentations skills of the students will be assessed to determine their ability in achieving this outcome. The first presentation is based on a topic related to computing ethics and the second is based on a technical Computer engineering topic.

Professional code of ethics and computing ethics issues are also covered in this course. In addition, aspects related to contemporary issues and impact of engineering solutions in a global and societal context are addressed in the course through invited speaker's presentations. Students will be asked to assess the achievement of the course outcomes at the end of the semester and these results will be used as part of the assessment of related program outcomes.

(vi) ***System Design Laboratory (COE 400)*****:**

The purpose of this course is to integrate student's knowledge of hardware and software in the design, implementation, debugging, and documentation of one major system. The twin learning experience of making hardware versus software decisions, and participating in a structured design are integrated into the same design exercise.

This course is taken by all Computer engineering students at the senior level and covers many of the program outcomes. Samples of students reports collected every semester are used to assess the covered outcomes using proper assessment rubrics.

(vii) ***Senior Design Project (COE 485)*:**

The purpose of this course is to integrate students' knowledge of hardware and software in the design. This course is designed to give students the experience of tackling a realistic engineering problem. The intent is to show how to put theoretical knowledge gained into practical use by starting from a word description of a problem and proceeding through various design phases to end up with a practical engineering solution. Various projects are offered by COE faculty in their respective specialization areas. The project advisor guides the student in conducting feasibility study, preparation of specifications, and the methodology for the design. Detailed design and implementation of the project are carried out followed by testing, debugging, and documentation. An oral presentation and a final report are given at the end of the semester.

All Computer engineering students in the non-coop program option take this course. It covers many of the program outcomes and provides a good assessment tool for measuring the achievement of those outcomes. Sample reports and presentations made by the students will be collected and evaluated using proper rubrics.

(viii) ***Cooperative Work (COE 350/351)*:**

This course is taken by all Computer engineering students in the coop program. It is based on a continuous period of 28 weeks spent in industry with the purpose of acquiring practical experience in different areas of Computer engineering. During this period, a student is exposed to the profession of Computer engineering by working in the field. Students are required to submit a final report and give a presentation about their experience and the knowledge gained during their cooperative work.

Sample of coop reports and presentations will be collected every semester and they will be evaluated using proper rubrics.

(ix) Summer Training *(COE 399)*:

The aim of summer training is to provide students with direct on-the-job experience working with professionals in the field. This training provides an opportunity to expose students to the reality of professional practice. Students are required to submit a report and make a presentation on their summer training experience and the knowledge gained.

Samples of students reports and presentations will collected every year and they will used to assess some of the program outcomes using proper rubrics.

The assessment and evaluation plan for the program outcomes is shown in Table V. For each program outcome, the assessment and evaluation methods are given. Scoring rubrics designed by the undergraduate committee are used for the assessment of outcomes. For each used assessment method, performance criteria are given indicating when an outcome is considered achieved. Finally, the frequency of assessment of each program outcome is indicated.

The assessment committee will perform the assessment process and collect all the needed data. The undergraduate committee will use the designed rubrics to evaluate the outcomes and determine whether they are met or not. It will then generate a summary of the assessment process, which will be presented to all faculty members in the department with recommendations for improvement. Once recommendations for improvement are approved by the department council, necessary changes will be implemented.

Examples of Rubrics designed for program outcomes assessment are given in Appendix II.

Table V. Program outcomes assessment and evaluation plan.

Program Outcome	Assessment & Evaluation Methods	Performance Criteria	Logistics
(a) an ability to apply knowledge of mathematics, science, and engineering	• Samples of COE 400, COE 485 and COE 351 reports • Math 101, Math 102, Math 201, Math 260, Phys. 101, Phys. 102, Chem. 101 • Exit exam • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • Average GPA ≥ 2.5 out of 4 • A score ≥ 60% • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester. However, grades of Math, Phys. & Chem. Courses will be collected and analyzed once a year.
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	• Samples of COE 400, COE 344 and COE 305 lab reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(c) an ability to design a system, component, or process to meet desired needs	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(d) an ability to function on multi-disciplinary teams	• Samples of COE 400, COE 485 and COE 351 reports • Peer & instructor evaluations in COE 400	• A score ≥ 2.5 out of 4 • A score ≥ 2.5 out of 4	Assessments will be conducted every semester.

	• Graduate Exit Survey • Coop Employer Survey	• A score ≥ 3 out of 5 • A score ≥ 3 out of 5	
(e) an ability to identify, formulate, and solve engineering problems	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(f) an understanding of professional and ethical responsibility	• IAS 211 • COE 390 Indirect Assessment • Graduate Exit Survey • Coop and Summer Training Employer Survey	• Average GPA ≥ 2.5 out of 4 • A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester. Grades for IAS 211 will collected and analyzed once a year.
(g) an ability to communicate effectively	• Samples of COE 400, COE 485, COE 399 and COE 351 reports • Sample COE 485 and COE 351 presentations • ENGL 214 • Graduate Exit Survey • Coop and summer training Employer survey	• A score ≥ 2.5 out of 4 • A score ≥ 2.5 out of 4 • Average GPA ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester except for COE 399 which will be assessed in a yearly basis. Grades for ENGL 214 will collected and analyzed once a year.
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(i) a recognition of the need for, and an ability to engage in life-long learning	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5	Assessments will be conducted every semester.

	• Coop Employer Survey	• A score ≥ 3 out of 5	
(j) knowledge of contemporary issues	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.
(l) Knowledge of Probability and Statistics and their applications in Computer Engineering	• STAT319 • Graduate Exit Survey • Coop Employer Survey	• Average GPA ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessment will be made every semester except for STAT319 which will be assessed in a yearly basis.
(m) Knowledge of Discrete Mathematics	• ICS 251 • Graduate Exit Survey • Coop Employer Survey	• Average GPA ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessment will be made every semester except for ICS251 which will be assessed in a yearly basis.
(n) The ability to design a system that involves the integration of hardware and software components	• Samples of COE 400, COE 485 and COE 351 reports • Graduate Exit Survey • Coop Employer Survey	• A score ≥ 2.5 out of 4 • A score ≥ 3 out of 5 • A score ≥ 3 out of 5	Assessments will be conducted every semester.

APPENDIX I

COE 202 Digital Logic Design

Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators & Details	Assessment Methods and Metrics	Min. Weight	ABET 2000
1. Ability to use math and Boolean algebra in performing computations in various number systems and simplification of Boolean algebraic expressions.	➢ Represent integer and fractional values in various number systems ➢ Convert number representation from one system to another ➢ Perform arithmetic operations in various number systems ➢ Represent data in different binary codes including error detecting codes ➢ Simplify Boolean expressions using Boolean algebra & identities	➢ Assignments ➢ Quizzes ➢ Exams	20%	A(H)
2. Ability to design efficient combinational and sequential logic circuit implementations from functional description of digital systems.	➢ Derive gate-level implementation of a given Boolean expression and vice versa ➢ Ability to build larger combinational functions using predefined modules (e.g., decoders, multiplexers, adders, Magnitude comparators.) ➢ Ability to build a state diagram / table for both Moore & Mealy models from functional description ➢ Ability to design & implement Moore & Mealy model synchronous sequential circuits using different Flip-Flop types. ➢ Ability to draw timing diagrams for major signals of both sequential and combination circuits	➢ Assignments ➢ Quizzes ➢ Exams	50%	C(H)
3. Ability to use CAD tools to simulate and verify logic circuits.	➢ Ability to simulate and verify the operation of combinational circuits ➢ Ability to simulate and verify the operation of sequential circuits	➢ Assignments	5%	K(L)

COE 203 Digital Logic Laboratory
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators & Details	Assessment Methods & Metrics	Min. Weight	ABET 2000 Criteria
1. The ability to design combinational and sequential circuits to meet certain specifications.	➢ Designing circuits from English language specs.	➢ Prelabs ➢ Experiments ➢ Quizzes ➢ Project ➢ Exams	30%	C(H)
2. The ability to use tools and discrete components, EEPROMs, FPGAs, to model, simulate and implement digital circuits.	➢ Implementing circuits from design specification. ➢ Modeling circuits in verilog or VHDL ➢ Verifying correct behavior by simulation	➢ Experiments	30%	K(H)
3. The ability to design and conduct experiments related to digital systems and to analyze their outcomes.	➢ Designing experiments to measure and analyze certain circuit parameters.	➢ Prelabs ➢ Experiments ➢ Exams	10%	B(M)
4. The ability to work in teams.	➢ Working with groups.	➢ Project	5%	D(L)
5. The ability to communicate effectively.	➢ Submitting prelabs and lab reports.	➢ Experiments ➢ Projects	5%	G(L)

COE 205 Computer Organization & Assembly Language
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Ability to analyze, design, implement, and test assembly language programs.	• Instruction Set Architecture • Number (unsigned and signed) and character representation • Addressing modes • Syntax, semantics, and effect on flags of Pentium instructions. • Input/output. • Arithmetic and logic operations. • Flow-control structures. • Procedures. • Macros. • String manipulation. • Interrupt mechanism. • Implementation of Pseudo code algorithms in assembly language.	• Assignments • Quizzes • Exams • Project	55%	C(H)
2. Ability to use tools and skills in analyzing and debugging assembly language programs.	• Assembly language vs. machine language. • Assembling and linking assembly programs (including use of multiple files). • Use of debugger to analyze and debug programs. • Use of libraries.	• Lab work	4%	K(L)
3. Ability to design the datapath and control unit of a simple CPU.	• Fetch-execute cycle • Data, address and control busses • Register transfer • Data path design: 1-bus, 2-bus and 3-bus CPU. • Derivation of control steps for assembly instructions.	• Assignments • Quizzes • Exams	15%	C(M)

	• Hardwired Control unit design • Microprogrammed control unit design. • Fixed vs. variable instruction format.			
4. Ability to demonstrate self-learning capability.	• Ability to learn a course topic alone (e.g. Macros) • Course Project may involve topics not studied in the course	• Assignments • Quizzes	2%	I(L)
5. Ability to work in a team.	• Project is divided into separate parts that will be integrated for project completion.	• Project	2%	D(L)

COE 305 Microcomputer System Design
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
O1. Ability to apply knowledge of mathematics, probability and engineering in microprocessor based system design	➢ Analysis of bus Fan-in and Fan-out requirements, ➢ analysis of bus and processor timing, performance evaluation, ➢ CPU execution time ➢ memory access time and bandwidth ➢ wait state computation ➢ computation of timing delays ➢ I/O performance such as interrupt latency and DMA speed	• Quizzes • Assignments • Exams	10%	A(M)
O2. Ability to design, debug and test a small scale microprocessor system	➢ Design of Clock generation, Reset generation & synchronization, Wait state computation & generation, Ready synchronization, ➢ Address bus latching, data bus buffering, ➢ Design of Memory Map, Memory Address decoder, Memory Read and write logic ➢ Interfacing of RAM and EPROM memories. to processor(appropriate selection and connection of address bus, data bus, read/write control and chip select) ➢ Modes of I/O data transfer – Programmed or Polled I/O, Interrupt driven I/O, DMA ➢ Design of I/O Map, I/O address decoder and I/O Read and Write logic ➢ Interfacing of Parallel & Serial I/O devices to processor using peripheral chips 8255 PPI, 8254 PIT, 8259PIC, 8237DMAC, 16650UART - appropriate selection and connection of address bus, data bus, read/write control, chip select between processor and peripheral chips - data, control and status signal interconnections between peripheral chips and I/O devices - Programming of Peripheral interfacing chips	• Quizzes • Assignments • Exams • Lab work	35%	C(H)

	➢ debug and test the design as well as to develop small test program to test the design correctness and timing versus some requirements. ➢ Revise the design appropriately ➢ Report and document the design.			
3. Ability to identify, formulate, and solve engineering problems in microprocessor based system design	➢ Identify, formulate and solve engineering problems in the microprocessor based system design considering the following : - Enhancements in the processor internal architecture, processor address & data bus width - Latest trends and developments in Memory Technology (SRAM, DRAM, SDRAM, RDRAM, DDR/DDR2) - Recent developments in I/O interfacing standards and I/O devices	• Quizzes • Assignments • Exams • Lab work	25%	E(H)
4. Ability to use design tools for microprocessor system design, test and evaluation.	➢ Use of tools for debugging, develop techniques for testing, and use of trace analysis and timing for evaluation ➢ Use of Logic analyzers, oscilloscopes, logic probes, multimeters ➢ Use of 8086 Flight Electronics kits to conduct I/O interfacing experiments.	• Lab work	8%	K(L)

5. Ability to engage in self-learning	➢ Demonstrates reading and writing skills ➢ Identifying, retrieving, and organizing information ➢ Following a learning plan ➢ Demonstrate critical thinking skills such as applying the facts, formulae, theories, etc. to everyday situations.	• Assignments • Quizzes • Exams	2%	I(L)
6. Ability to function as an effective team member.		• Lab work	5%	D(L)
7. Ability to design and conduct experiments as well as to analyze and interpret data.		• Lab work	5%	B(L)

COE 308 Computer Architecture
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
O1. Ability to apply knowledge of mathematics, probability, and statistics in computer analysis and design.	• Integer representation, addition, and multiplication • Floating-point representation, rounding, normalization, addition, and multiplication. • Program and instruction execution times and stall cycles. • Speedup computation • Evaluation of the average performance of I-pipelining and memory system	• Assignments • Quizzes • Exams	40%	A(H)
O2. Ability to design the datapath and control of a processor.	• Design generic datapath based on Instruction Set requirements. • Identify datapath components and clocking methodology. • Design a detailed single-cycle integer datapath, Muxes, and PC updating. • Identify control signals and design control logic • Design inter-stage buffers and clocking for multicycle datapath. • Design multi-cycle control states and logic. • Design pipelined datapath and control • Detect and eliminate structural hazards • Detect data hazards and implement forwarding • Handle control hazards and predict branches	• Assignments • Quizzes • Exams • Project	20%	C (H)

O3. Ability to identify, formulate, and solve computer architecture problems.	• Assess design methodologies in single-cycle, multi-cycle, and multiple-issue datapaths. • Assess tradeoffs in cache design, page size, bus width, degree of associativity, cache capacity, and main memory access time. • Assess tradeoffs in address translation, virtual page size, TLB size, sequential versus concurrent TLB and cache access. • Assess scalability issues in shared-memory and distributed-memory systems.	• Assignments • Quizzes • Exams	5%	E (L)
O4. Ability to use simulator tools.	• Ability to set up a simulator. • Set up simulation runs based on some design specifications. • Run simulations and collect results and statistics • Ability to analyze simulation results and modify design specifications to improve performance.	• Assignments • Mini-group Projects	2%	K(L)
O5. Ability to engage in self-learning.	• Demonstrates reading, writing, listening and speaking skills • Identifying, retrieving, and organizing information • Following a learning plan • Demonstrate critical thinking skills such as applying the facts, formulas, theories, etc. to everyday situations.	• Mini-group Projects • Assignments • Quizzes • Exams	2%	I(L)

COE 341 Data and Computer Communications
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Ability to apply knowledge of mathematics to understand basic concepts in communication engineering	Application of : • Fourier series and transforms • Spectral power density to understand the following concepts: • Absolute and effective bandwidth of signals. • Filtering and band limiting • Modulation and bandwidth requirements	• Assignments • Quizzes • Exams	15%	A(M)
2. Ability to design basic communication systems, components, and algorithms	The student shall be able to design: • Simple communication links using various types of guided and unguided media. • Hardware for generating CRC error detection codes and performing error detection. • Bit stuffing/unstuffing algorithms for HDLC control. • Basic PCM and Delta modulation systems.	• Assignments • Quizzes • Exams	22%	C(H)
3. Ability to identify, formulate, analyze, and solve basic communication engineering problems	The student shall be able to identify merits and trade offs governing the choices of: • Analog and digital transmission techniques. • Various digital encoding schemes, including bandwidth requirements. • Various error and flow control mechanisms in the data link layer. • Various modulation techniques, including bandwidth requirements.	• Assignments • Quizzes • Exams	22%	E(H)

	• Various guided and unguided transmission media. • Synchronous and asynchronous transmission. • Data rate, signal power, noise level, bandwidth and error rate.			
4. Ability to use programming tools and skills for the simulation, analysis, and design of basic communication systems and components	Matlab or LabVIEW-based programming assignments covering one of the following areas: • FFT • Filters • CRC generation and error detection • Generation of digital codes • Modulation and shift keying • PCM and Delta modulation systems • Calculation of bit error rate vs signal to noise ratio curves	• Programming Assignments • Demos	8%	K(L)
5. Ability to demonstrate self learning skills and aptitudes	A term paper on a selected topic in communications that complements/serves the course.	• Term paper • Presentation	5%	I(L)

COE 344 Computer Networks
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Ability to apply knowledge of mathematics, probability, and statistics to model and analyze some networking protocols.	• Packet and circuit switching modeling, analysis, and comparison. • Modeling of some MAC protocols.	• Assignments • Quizzes • Exams	**18%**	A(M)
2. Ability to design, implement, and analyze simple computer networks.	• Experiments on LAN design and implementation. • Protocol analysis. • Use of networking tools.	• Lab assignments • Lab work	**6%**	B(L)
3. Ability to identify, formulate, and solve network engineering problems.	• Identify and solve reliable data transfer problems over IP Networks. • Identify and solve network addressing problems. • Identify, compare, and contrast different routing protocols.	• Assignments • Quizzes • Exams • Lab work	**35%**	E(H)
4. Knowledge of contemporary issues in computer networks.	• Contemporary networking technologies.	• Assignments	**5%**	J(L)

5. Ability to use techniques, skills, and modern networking tools necessary for engineering practice.	• Setup networking services. • Setup and basic configuration of networking devices. • Networking tools. • Traffic analyzers. • Troubleshooting network problems. • Different operating systems.	• Lab work.	**9%**	K(L)

COE 360 Principles of VLSI Design
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. An ability to apply knowledge of mathematics, science, and engineering in the design, analysis and modeling of digital integrated circuits	• energy bands formation • MOS threshold voltage • MOS current equations • Delay of MOS circuits • Noise margins • Optimization of buffer chains and logic paths	• Assignments • Quizzes • Exams	**5%**	A(L)
2. An ability to design and conduct experiments using SPICE to characterize and optimize digital integrated circuits	• Noise Margins adjustments • Rise and Fall times adjustments • Delay adjustments • Driving capabilities of I/O buffers	• Assignments • Project	**5%**	B(L)
3. Ability to Design, Verify, Analyze and Evaluate the performance (speed, Power, Area, Noise margins) of different MOS digital integrated circuits for different design specifications .	• Design of MOS circuits	• Assignments • Quizzes • Project • Exams	**40%**	C(H)
4. An ability to use various CAD tools in the design and verification of digital integrated circuits	• LogicWorks/ModelSim/Xilinx for logic design/verification • SPICE for circuit design/analysis/verification • Magic and IRSIM for mask design/verification	• Assignments • Project	**15%**	K(M)

5. An ability to function as an effective team member.	• Project task assignment and integration.	• Project	**2.5%**	D(L)
6. An ability to communicate effectively.	• Project report(s)	• Project	**2.5%**	G(L)

COE 390 Seminar
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Knowledge of contemporary issues.	Invited presentations on contemporary issues will be given.	Presentation Assignments	**10%**	J(M)
2. Ability to make effective presentation.	All students will be asked to prepare and deliver professional presentation Presentation organization Ability to explain Use of modern presentation tools and methods.	Presentation Seminar attendance	**30%**	G(H)
3. Knowledge of professional and ethical responsibility	A presentation will be about professional and ethical responsibility.	Punctuality On time submission Proper referencing Presentation.	**15%**	F(M)
4. Understanding the impact of engineering solutions in a global and societal context.	Invited presentations focusing on this issue will be given	Assignments	**5%**	H(L)
5. Ability to engage in life-long learning.	Paper presentations of recent technical topocs in the field.	Presentations	**15%**	I(M)

COE 400 Digital System Design
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Ability to apply knowledge of mathematics, science and Engineering in design and analysis of different alternative implementations of a system's specification.	• Ability to estimate the computational complexity of a particular algorithm for solving an engineering problem starting from a problem statement • Ability to use knowledge of physics and math to perform power conversions • Ability to use knowledge of physics and engineering to design the proper interface when applying embedded systems to solve practical problems like in motor control for example • Ability to use knowledge of science and engineering to be able to read, understand and analyze data sheets of required products to solve engineering problems	• Project	10%	A(M)
2. Ability to design and implement an embedded system starting from given specifications.	• Ability to understand Microcontroller architecture, interfacing principles • Ability to understand and use Engineering Design trade-offs: - software/hardware trade-off - cost/performance trade-off • Ability to interface sensors/actuators to a microcontroller • Ability to perform low power design • Ability to understand and utilize hard and soft real-time issues •	• Assignments • Quizzes • Project	25%	N (H)

3. Ability to debug and test an embedded system.	• Ability to integrate software and hardware and validate their compliance with the original specification instructions. • Ability to acquire software development and debugging skills • Ability to understand and develop Software using available tools. • Ability to understand Data Logging Concepts.	• Project	10%	B(M)
4. Ability to identify, formulate, and solve engineering problems such as the selection of most appropriate solutions for solution criteria.	• Ability to assess various microcontrollers' specifications. • Assess tradeoffs between various communications standards used in microcontroller based systems. • Assess tradeoffs between centralized and distributed microcontroller based designs.	• Assignments • Quizzes • Exams	5%	E (L)
5. Ability to use tools to achieve design objectives.	• Ability to set up a simulator • Ability to learn how to use a typical microcontroller development system. • Ability to set up simulation runs based on some design specifications • Ability to run simulations and collect results • Ability to use CAD tools professionally for designing the intended embedded system	• Assignments • Project	5%	K(L)
6. Ability to function as an effective team member.	• Ability to establish task priorities and clearly state expectations • Ability to keep the team focused • Ability to be flexible and adapt to demands of situations and constraints • Ability to maintain an appropriate balance between listening and speaking	• Project	15%	D(M)

7. Ability to engage in self-learning.	• Ability to demonstrate reading, writing, and speaking skills • Ability to Identify, retrieve, and organize information from the web • Ability to follow a learning plan • Ability to demonstrate critical thinking skills.	• Project	5%	I(L)
8. Ability to communicate effectively.	• Ability to submit progress reports on milestones of the project • Ability to deliver a number of presentations to the class	• Project	10%	G(M)

COE 485 Senior Design Project
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. Ability to apply knowledge of mathematics, science, and engineering	• Developing solutions that utilize fundamental scientific and engineering concepts.	• Final report	5%	A(L)
2. Ability to design and conduct experiments, as well as to analyze and interpret data .	• Design and conduct experiments (including simulation and/or emulation) to explore the design space • Collect, analyze and interpret data	• Demos • Progress/Final reports	10%	B(M)
3. Ability to design a system, component, or process to meet desired needs	• System design from high level specifications • Detailed design of the required components • Implementation of a prototype	• Demos • Progress/final reports	20%	C(H)
4. Ability to identify, formulate, and solve engineering problems	• Defining formal specifications from the problem statement. • Examination of different approaches.	• Progress/final reports	10%	E(M)
5. Understanding of professional and ethical responsibility	• Presentation of original work and proper referencing of existing art. • Meeting deadlines and proper planning.	• Progress report • Action plan • Final report	5%	F(L)
6. Ability to communicate effectively	• Ability to clearly document the work • Effectively communicate the project details orally	• Presentation • Progress/final Reports	15%	G(M)

7. The broad education necessary to understand the impact of engineering solutions in a global and societal context	• Understanding the impact of his solution to the society such as: healthcare, e-commerce…etc.	• Oral presentation • Final report	2%	H(L)
8. A recognition of the need for, and an ability to engage in life-long learning	• Providing solutions that were not taught in core courses	• Report • Presentations • Discussions	5%	I(L)
9. knowledge of contemporary issues	• Understating the impact of contemporary issues on his design	• Oral presentation • Final report	2%	J(L)
10. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	• Demonstrate the use of engineering software/hardware tools	• Demos • Progress/final reports	10%	K(M)
11. Ability to function as an effective team member.	• Demonstrate team work skills in project planning, division of work, team leadership, etc.	• Presentation • Progress/final Reports	10%	D(M)

COE 351 Cooperative Work
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. An ability to design a system, component, or process to meet desired needs	▪ Problem statement, clarity, logic, and relevance ▪ Analysis of possible solutions, knowledge in the field, specification, engineering solution ▪ Tradeoffs and selection of solution, assessment, evaluation, and comparison ▪ Implementation, design, schematic, and diagrams ▪ Testing, test selection, evaluation, linking features, and conclusion.	▪ Company Supervisor report ▪ Employer Survey • Progress and Final reports • Presentation	20%	C(H)
2. An ability to function as an effective team member	▪ Contribute in all tasks within the team, ▪ Come on time and leave on time, ▪ Shares accountability for team results, ▪ Is comfortable dealing with open-ended problems, ▪ Treats others with courtesy and respect, ▪ Conveys openness to new ideas, ▪ Supports the ideas and viewpoints of others.	▪ Company Supervisor report ▪ Employer Survey • Progress and Final reports • Presentation	10%	D (M)
3. An ability to communicate effectively	Presentation: ▪ Style, voice, gesture, motion, and self-confidence, ▪ Audio-visual quality, ▪ Content: logical ideas, objective clarity, and effective timing ▪ Audience: appropriateness of content ▪ Technical: recommendation and discussion quality, originality, innovation Report: ▪ Understanding: grammar, spelling, and punctuation, structures, subject vocabulary, and structured ▪ Tools: diagrams, photos, and graphs, labels and references ▪ Logical ideas: logical manner, and referenced material	▪ Company Supervisor report ▪ Employer Survey • Progress and Final reports • Presentation	20%	G (H)

	▪ Technical information: precision, and engineering principles ▪ Outcomes: supports outcomes, recommendations and discussion ▪ Report quality: meeting objectives, comprehensive material, originality, and innovation			
4. A recognition of the need for, and an ability to engage in life-long learning	▪ Demonstrates reading, writing, listening and speaking skills, ▪ Demonstrate an awareness of what they need to learn, ▪ Following a learning plan, Identifying, retrieving, and organizing information, ▪ Understand and remember new information, ▪ Demonstrate critical thinking skills, ▪ Demonstrate ability to reflect on own understanding	▪ Company Supervisor report ▪ Employer Survey • Progress and Final reports • Presentation	10%	I(M)
5. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	▪ Carry out mathematical analysis ▪ Write programs, ▪ Use conventional bench testing equipment ▪ Working knowledge of a modern programming language ▪ Use various applications packages ▪ Understand the purposes and limitations of applications packages, and when it is appropriate to use them and when it is not.	▪ Company Supervisor report ▪ Employer Survey ▪ Progress and Final reports ▪ Presentation	15%	K(M)
6. Understanding of professional and ethical responsibility	▪ Presentation of original work and proper referencing of existing art. ▪ Meeting deadlines and proper planning.	▪ Progress report ▪ Action plan ▪ Final report ▪ Company Report	10%	F(M)

COE 399 Summer Training
Course Learning Outcomes Table

Course Learning Outcomes	Outcome Indicators and Details	Assessment Methods and Metrics	Min. Weight	ABET 2000 Criteria
1. An ability to function as an effective team member	▪ Contribute in all tasks within the team, ▪ Come on time and leave on time, ▪ Shares accountability for team results, ▪ Is comfortable dealing with open-ended problems, ▪ Treats others with courtesy and respect, ▪ Conveys openness to new ideas, ▪ Supports the ideas and viewpoints of others.	▪ Company Evaluation	10%	D (M)
2. An ability to communicate effectively	Presentation: ▪ Style, voice, gesture, motion, and self-confidence, ▪ Audio-visual quality, ▪ Content: logical ideas, objective clarity, and effective timing ▪ Audience: appropriateness of content ▪ Technical: recommendation and discussion quality, originality, innovation Report: ▪ Understanding: grammar, spelling, and punctuation, structures, subject vocabulary, and structured ▪ Tools: diagrams, photos, and graphs, labels and references ▪ Logical ideas: logical manner, and referenced material ▪ Technical information: precision, and engineering principles ▪ Outcomes: supports outcomes, recommendations and discussion ▪ Report quality: meeting objectives, comprehensive material, originality, and innovation	▪ Company Evaluation • Progress and Final reports • Presentation	25%	G (H)

3. A recognition of the need for, and an ability to engage in life-long learning	▪ Demonstrates reading, writing, listening and speaking skills, ▪ Demonstrate an awareness of what they need to learn, ▪ Following a learning plan, Identifying, retrieving, and organizing information, ▪ Understand and remember new information, ▪ Demonstrate critical thinking skills, ▪ Demonstrate ability to reflect on own understanding	▪ Company Evaluation • Final report • Presentation	15%	I(M)
5. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	▪ Carry out mathematical analysis ▪ Write programs, ▪ Use conventional bench testing equipment ▪ Working knowledge of a modern programming language ▪ Use various applications packages ▪ Understand the purposes and limitations of applications packages, and when it is appropriate to use them and when it is not.	▪ Company Evaluation ▪ Progress and Final reports ▪ Presentation	30%	K(H)
6. Understanding of professional and ethical responsibility	▪ Presentation of original work and proper referencing of existing art. ▪ Meeting deadlines and proper planning.	▪ Progress reports ▪ Company Evaluation	10%	F(M)

APPENDIX II

Program Outcomes Assessment Rubrics

(a) ***Ability to apply knowledge of mathematics, science, and engineering***

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Hierarchical top-down design partitioning based on sound mathematical, scientific, or engineering basis	Correct hierarchical top-down partitioning of the design in a logical, easy-to-implement, or readily available modules.	Correct hierarchical top-down partitioning of the design in a logical but more complex to implement modules.	Hierarchical top-down partitioning of the design in a less logical manner or with some erroneous mathematical, scientific or engineering basis..	Incorrect hierarchical top-down partitioning of the design.
Identification of proper mathematical / scientific /engineering model for each module.	Properly identifies scientific, mathematical, algorithmic, or engineering basis for all modules in the design hierarchy	Properly identifies scientific, mathematical, algorithmic, or engineering basis for most modules in the design hierarchy	Properly identifies scientific, mathematical, algorithmic, or engineering basis for some (but not most) modules in the design hierarchy, or Partially identifies scientific, mathematical, algorithmic, or engineering basis for most modules in the design hierarchy	Improper identification of the scientific, mathematical, algorithmic, or engineering basis for most modules in the design hierarchy
ability to apply mathematics, science, and engineering	Always uses the proper mathematical, and scientific formulation to solve problems	Uses the proper mathematical, and scientific formulation to solve problems most of the times	Uses the proper mathematical, and scientific formulation to solve problems some of the times	Rarely uses the proper mathematical, and scientific formulation to solve problems

(b) Ability to design and conduct experiments, as well as to analyze and interpret data

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Ability to design and conduct an experiment to identify/quantify/evaluate performance of system or part of a system (Hardware, software or both):				
1. Identifying clear goals for the experiment	Clearly identify the objectives of the experiment, the expected results, and possible pitfalls to watch for.	Clearly identify the objectives of the experiment and some of the expected results but does not think of the possible pitfalls.	Identify some of the objectives of the experiment but omits the expected results and possible pitfalls	Does not identify any objectives for the experiment and/or expected results
2. Choosing the appropriate experimental test bed (Hardware, Software, Emulation, Simulation or hybrid) to achieve the identified objectives of the experiment	Chooses the best test bed suitable for achieving the objectives with proper justification	Chooses the best test bed suitable for achieving the objectives with no justification	Chooses a test bed that is not optimum but somehow achieves the identified objectives	Chooses a test bed that does not achieve the objectives at all
3. Designing and conducting the experiment	Student groups design and conduct the experiment with no errors at all	Student groups design and conduct the experiment with some minor errors that do not adversely affect the objectives	Student groups design and conduct the experiment with some errors that affect the results and the objectives	Student groups design and conduct the experiment with major conceptual or procedural errors that render the results useless and leave the objectives unachieved
Ability to analyze and interpret the data	Analysis and interpretation of results exceed requirements of experiment and demonstrate significant higher-order thinking ability.	Analysis and interpretation of results meet requirements of experiment and demonstrate some higher-order thinking ability.	Results are analyzed but not interpreted; very limited evidence of higher-order thinking ability.	No evidence of significant analysis and interpretation of results; fail to meet requirements of the experiment; demonstrate only lower-level thinking ability

(c) an ability to design a system, component, or process to meet desired needs

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Translate general requirements into specific system behavior and features	Requirements are translated accurately and with great precision into	Requirements are translated accurately into system behavior and	Requirements are not translated accurately into system behavior	Specification does not follow the requirements consistently. Several

	system behavior and features clearly described without ambiguity and without entering into any design details	features clearly described with some ambiguity. The description of behavior and features enters into some details and proposes design solutions thinking it is just translating the requirements	and features. Some features not clearly described. Some consistency errors.	consistency errors. No clear difference between system behavior description and features and design solutions
Identify and formulate any problem that need to be addressed before being able to start designing (design feasibility)	Potential conceptual problems are addressed and properly formulated. Some system behavior is translated into some mathematical formulas describing necessary conditions for the system to function properly or alike	Potential conceptual problems are addressed but not properly formulated. Some system behavior is translated into some mathematical formulas describing necessary conditions for the system to function properly with some errors on the assumptions.	Potential conceptual problems are recognized but not properly formulated. No system behavior is translated into some mathematical formulas describing necessary conditions for the system to function properly.	Potential conceptual problems are not identified in any way.
List different design alternatives for the overall system (design feasibility)	Different design alternatives are proposed and clearly discussed and compared. The comparison is rigorous and accurate.	Different design alternatives are proposed and clearly discussed and compared. Some rigor missing in the comparison although accurate statements are made.	A small subset of the possible design alternatives is considered. No thorough comparison is performed and statements are not accurate.	No design alternatives are proposed.
Choose the appropriate design solution using technical and economic criteria	The analysis of the technical and economic constraints leads to the optimal design solution. The justification and argumentation is thorough, accurate and consistent.	The analysis of the technical and economic constraints leads to the optimal design solution. The justification and argumentation is accurate and consistent but not thorough. Missing justifications for some aspects.	The analysis of the technical and economic constraints does not lead to the optimal design solution. The justification and argumentation are a little accurate and superficial.	The design solution is presented without any analysis. Some inappropriate justification and argumentation is present with a lot of inconsistencies.

(d) Ability to function on multi-disciplinary teams

The assessment process for the Teamwork is composed of two parts. The first will be peer evaluation where every member in a team will evaluate his peers in the same team. The second will be done by the course instructor or the assessment committee which will depend mainly on the final report and log book submitted by each group. These rubrics are designed for evaluating the role of individuals in acquiring this skill.

PART-I: Peer Evaluation Rubrics:

Category	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.
Problem-solving	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions, but is willing to try out solutions suggested by others.	Does not try to solve problems or help others solve problems. Lets others do the work.
Attitude	Is never publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Is rarely publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Is occasionally publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Is often publicly critical of the project or the work of other members of the group. Is often negative about the task(s).
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on task.	Rarely focuses on the task and what needs to be done. Lets others do the work.
Working with Others	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.

PART-II: Project-Based Teamwork Assessment Rubrics:

	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Teamwork	1. The work load and variety on each member seems fair 2. Leadership role being	1. The work load and variety on each member seem fair 2. Leadership role being	1. The work load and variety on each member does not seem to be fair or at least one	1. The work load and variety on each member does not seem to be fair or at least

	assumed by each member for different tasks is evident 3. scheduled meetings minutes are Always recorded and the contribution of each team members are identified	assumed by each member for different tasks is NOT apparent 3. scheduled meetings minutes are Usually recorded and the contribution of each team members are identified	member has been assigned trivial non-technical tasks (e.g. writing the report) 2. Scheduled meetings minutes are Often recorded and the contribution of each team members are NOT identified	one member has been assigned trivial non-technical tasks (e.g. writing the report) 2. Scheduled meetings minutes are Rarely recorded and the efforts are scattered.

(e) Ability to identify, formulate, and solve engineering problems

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Applying concepts, governing math or physics equations and algorithms to solve a problem	Applies correct concepts, chooses correct governing equations and optimum algorithms (or methods) to solve a problem.	Applies correct concepts, chooses correct governing equations but use sub-optimum algorithms (or methods) to solve a problem.	Applies some correct concepts and chooses some correct governing equations but makes mistakes	Applies incorrect concepts and/or chooses incorrect governing equations → can not solve problems
Demonstrating effective open-ended problem solving techniques (including the debugging of a faulty design; hardware, software or both)	Always solves problems using step-by-step logical procedure and obtain correct solution	Mostly solves problems using step-by-step logical procedure. Sometimes he solves problems in an ad-hoc manner, but still he obtains correct solutions	Mostly solves problems using step-by-step logical procedure but some times makes minor procedural errors that lead to incorrect solution of the problem	Solves problems without logical step-by-step logical procedure and makes procedural errors resulting in incorrect solution

(f) an understanding of professional and ethical responsibility

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Understanding of ethical and professional issues	Deep understanding of the professional issues involved and the ethical implications of the solution; careful,	Good understanding of all the professional/ethical issues related to the solution; reasonable analysis of the relevant issues	Some consideration of professional, ethical issues raised directly by the solution	Little or no understanding of professional/ethical issues even where there are serious questions involved

	convincing analysis of all relevant factors.			

(g) <u>an ability to communicate effectively</u>

Writing Skills Assessment

Report Quality and Writing Skills:	**Exemplary (4)**	**Proficient (3)**	**Apprentice (2)**	**Novice (1)**
1. Spelling and Grammar	Almost no spelling and/or grammatical mistakes (≤ 0.2 mistake/page)	Rare spelling and/or grammatical mistakes (≤ 0.5 mistake/page)	Makes noticeable frequent spelling and/or grammatical mistakes (≤ 1 mistake/page)	Makes frequent spelling and/or grammatical mistakes (≥ 1 mistake/page)
2. Punctuation	Proper use of punctuation, sentences are not too long, no repetition of words, proper use of paragraphs	Proper use of punctuation, sentences are sometimes too long, some repetition of words, proper use of paragraphs	Some improper use of punctuation, sentences are usually too long, many repetition of words, some improper use of paragraphs	No use of punctuation at all … Sentences seems to go on and on for ever … No apparent usage of paragraphs
3. Structure and Organization (choice of fonts, titles, sub-titles, chapters, sub-chapters, sections, sub-sections to enhance the readability and understanding of the report), having a table of content, list of Figures and tables	Superb structure of the report, everything makes sense (understand templates and can follow them exactly), perfect table of content, list of Figures and tables	Good Structure and organization with some departure from the ideal template, good table of content, list of Figures and tables	The structure and organization are not good … noticeable departure from template, poor table of content, list of Figures and tables	The structure and organization of the report seem to be random ... Does not follow the template at all … missing table of content, list of Figures or tables

4. Use of visual illustrations, other than plain text, (graphs, charts, flow diagrams, tables …) to enhance the understanding of the report	**All** information that can be represented graphically is presented as such with **proper** choice of the illustration method that suits the information being presented the most	**Most** information that can be represented graphically is presented as such with **Good** choice of the illustration method that suits the information being presented the most	Most information that can be graphically illustrated is presented as plain text. Some information is illustrated graphically with some wrong illustration methods	Information is rarely illustrated graphically with improper choice of illustration methods
5. Formulae and equations	**All** formulae and equations used are properly written, numbered and referenced	**Most** formulae and equations used are properly written, numbered and referenced	**Most** formulae and equations used are properly written but many are not numbered and referenced	**Many** formulae and equations used are improperly written and most of them are not numbered and referenced
6. Proper use of References	All information obtained from others is properly referenced. The list of references is properly documented (source name, publication name, page numbers, …etc.)	Most information obtained from others is properly referenced. The list of references is properly documented (source name, publication name, page numbers, …etc.)	Some use of references, most information is not referenced. List of references is not properly documented (some information is missing, like page numbers ….etc.)	No referencing at all
7. Proper use of appendices (to reduce the size of the main body of the report)	All the information that is not critical to the	Most of the information that is not	Most of the information that can be put in	No use of appendices at all. Everything is in the

	understanding of the report but might be of some interest to some of the readers is put in the appendices. Appendices are properly organized (multiple appendices are used for different information)	critical to the understanding of the report but might be of some interest to some of the readers is put in the appendices. Appendices are properly organized (multiple appendices are used for different information)	appendices are spread through the main body of the report. Only one (or few) appendices are included containing many, unrelated, information	main body of the report

Technical Contents	**Exemplary (4)**	**Proficient (3)**	**Apprentice (2)**	**Novice (1)**
1. The abstract	Precise, completely conveys what has been accomplished, provide performance numbers with a good first punch line	Completely conveys what has been accomplished, provide performance numbers, no punch line, too many words	Somehow conveys what has been accomplished … No performance numbers	No abstract at all or what is provided as an abstract is not an abstract!
2. Problem description and motivation	The problem being tackled is clearly described with proper usage of statistics, market surveys, news articles …etc. to support the motivation for tackling this problem	Clear problem description but vague (or little support) motivation	Somehow vague problem description, no motivation or justification for tackling this problem at all	Vague problem description (one can not tell exactly what he is trying to do or why)
3. Objectives & Deliverables	Measurable objectives and deliverables are clearly and precisely stated	Objectives and Deliverables are stated with some vagueness (making them less measurable)	Some objectives and deliverables are provided (many are missing), however they are not clear nor measurable	Objectives 7 deliverables are not stated at all

4. Project Management Plan	A **well** written work plan is provided detailing phases or milestones, tasks, task assignment, task duration, critical path analysis and contingency plans, required resources, and discrepancies between planned and achieved tasks. Tasks are clearly and precisely stated (**one can** tell what is the expected outcome of a task just by reading the task)	A work plan is provided with some details about tasks (no phases or milestones), tasks, task assignment, task duration, required resources, and discrepancies between planned and achieved tasks. **No critical path analysis and contingency plans**. Some tasks are vaguely stated (one **can not** tell what is the expected outcome of a task just by reading the task)	A very brief work plan is provided with very little description of tasks. Tasks are very vague.	No work plan is provided at all
5. Quality of Engineering Documentation	Engineering principles are well developed, Possible solutions are well documented, Proper description of solution, Proper Documentation of experimental setup , data acquisition, Analysis, results, testing, benchmarking (all that apply) and conclusions	Generally sufficient documentation of possible solutions, adopted solution, experimental setup , data acquisition, Analysis, results, testing, benchmarking (all that apply) and conclusions Some items might not be sufficiently documented	Some documentation is provided but some major components are missing	Documentation is generally inadequate

ORAL PRESENTATION ASSESSMENT

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Audience awareness (interacts with audience: e.g.				

stepping toward audience and speaking to them, not at them), looking at them, making eye contact	Interacts with audience throughout presentation	Some interaction with audience	Little interaction with audience … Most of the time looks elsewhere	Does not interact with audience at all … Does not look at the audience … Look at PC, screen, or elsewhere
Focus: goal, evidence, conclusion (gives audience a roadmap and follows it)	Gives audience very clear road map of goal, evidence and conclusion and follows it well	Gives audience an adequate road map of goal, evidence and conclusion and follows it adequately	Gives audience some road map of goal, evidence and conclusion but does not follow it well	Does not give audience an adequate road map of goal, evidence and conclusion
Transitions (phrases smoothly link one part to next)	Very smooth Transitions	Transitions are generally smooth	Some transition is provided though not smooth	Abruptly transitions from one phase to the next … No linking
Use of visual aids (to tell the story and enhance the quality of the presentation)	Uses visual aids very effectively to tell the story; visual aids enhance presentation	Overall, uses visual aids effectively to tell the story; visual aids add to presentation	There is some use of visual aids effectively to tell the story	Either does not use visual aids at all; or too much dependency on visual aids

Mechanics	**Exemplary (4)**	**Proficient (3)**	**Apprentice (2)**	**Novice (1)**
	Very effectively uses (e.g.'s):	Effectively uses (e.g.'s):	Sometimes effectively use (e.g.'s):	Does not effectively use (e.g.'s):
Body position (e.g., facing audience or screen)	Body position (always facing audience)	Body position (faces audience most of the time)	Body position (faces audience some of the time)	Body position (faces screen or board all the time)
Eye contact: (e.g., scanning entire audience)	Eye contact (excellent scanning of audience, looking at people)	Eye contact (some scanning of audience, looking at people)	Some eye contact (not enough, looking down a lot)	No eye contact
Visual aids (e.g., clear, not too busy, readable size font)	Visual Aids (clear, right amount on each slide)	Visual Aids (can read clearly, usually not too much material)	Visual Aids (a little bit busy, sometimes not clear)	Visual Aids (too busy, blurry)

Delivery (e.g., fluency, pace, voice projection, um's, uh's)	Delivery (excellent pace, projects voice, great enthusiasm)	Delivery (good pace, usually projects voice, some enthusiasm)	Delivery (a little bit fast, sometimes um's, little projecting voice, little enthusiasm)	Delivery (too fast, too many um's, not projecting voice, lack of enthusiasm)

Questions	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Asks audience for questions	Effectively opens ("I'd be happy to answer questions")	Asks for questions	rarely ask for questions	Does not ask for questions
Answers questions effectively and smoothly	Answers questions effectively and smoothly	Answers questions adequately	Rarely answer questions adequately	Does not answer questions adequately

(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Awareness of global effects of engineering solutions (product, practice, event)	Deep understanding of the immediate and long-term issues involving the solution on users and non-users locally and globally	Good understanding of the widespread effects of the solution but with somewhat limited perspective about long-term factors	Some awareness of the more extended effects of the solution	Seems to have considered only effects on immediate users
Understanding of economic factors	Deep understanding of economic factors applied to this and	Good understanding of economic factors as applied to this solution	Some understanding of economic factors as applied to the solution	Little or no understanding of economic factors

	related solutions and the impact they may have on the economy at large as well as long term trends	and how it affects other related solutions		involved in the creation and/or use of the solution
Awareness of implications to society at large	Deep understanding of the immediate and long term implications to society in the creation and/or use of the solution, and the overall potential benefits and risks to society.	Good understanding of the implications to society in the creation and/or use of the solution, as well as its relation to general societal issues	Moderate understanding of the implications to society in the creation and/or use of the solution	Little or no understanding of (or interest in?) implications to society involved in the creation and/or use of the solution

(i) A recognition of the need for, and an ability to engage in life-long learning

Category	**Exemplary (4)**	**Proficient (3)**	**Apprentice (2)**	**Novice (1)**
Importance of lifelong learning	Demonstrates extensive understanding of the importance of lifelong learning	Demonstrates substantial understanding of the importance of lifelong learning	Demonstrates basic understanding of the importance of lifelong learning	Demonstrates little or no understanding of the importance of lifelong learning.
Independency	Routinely demonstrate the ability to find, evaluate and use resources to learn independently	Usually demonstrate the ability to find, evaluate and use resources to learn independently	sometimes demonstrate the ability to find, evaluate and use resources to learn independently	Rarely demonstrate the ability to find, evaluate and use resources to learn independently.
Personal responsibility	Displays exceptional recognition of the need to accept personal responsibility	Displays sufficient recognition of the need to accept personal responsibility	Displays minimal recognition of the need to accept personal responsibility	Does not recognize the need to accept personal responsibility
Critical Thinking	• Demonstrate the ability to o Gather new data, use information well, understands concepts within standards. o Know and understand the facts, new	• Demonstrate the ability to o Gather new data, use information well, understands concepts within standards. o Know and understand the facts, new thoughts developed	• Demonstrate the ability to o Gather new data, use information well, understands concepts within standards.	• Demonstrate the ability to o Gather new data

	thoughts developed on basis of new information. o Use Information/knowledge used in multiple "real" contexts.	on basis of new information.		

(j) knowledge of contemporary issues

	Exemplary (4)	**Proficient (3)**	**Apprentice (2)**	**Novice (1)**
Awareness of (other) contemporary issues (political, cultural, ...)	Deep understanding of all the relevant contemporary issues related to the creation and/or use of the solution, as well as of issues that may be only tangentially related; good analysis of all these issues and how they might impact the general acceptance of the solution and how this might affect the future development of similar solutions.	Good understanding of all the relevant contemporary issues directly related to the creation and/or use of the solution.	Moderate understanding of the main relevant contemporary issues directly related to the creation and/or use of the solution	Little or no understanding of (or interest in?) contemporary issues directly related to the creation and/or use of the solution

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Tool Selection	Selection of tools is based on sound technical criteria. Relevant industry standard class tools (software CAD, simulation, test equipment, emulators, measurement and lab equipment, planning and project management tools) are selected for carrying out specific tasks	Selection of tools is based on prior knowledge of the tools. Relevance of the selected tools is close to the standard practices.	Selection of tools is not based on technical criteria. Tools are selected based on personal preference	Selection of tools is not discussed. Use of the wrong set of tools is commonly noticed.
Tool Usage	Usage of the tools shows a good awareness of the tools capabilities and features. Tools are used correctly and in a consistent way with the stated objectives. Any issue with the tools is resolved using the tools documentation, FAQs or the customer support. Accurate description of credible problems encountered is noticed.	Usage of the tools is shows a fair awareness of the tools capabilities and features. Tools are used correctly and in a consistent way with the stated objectives. Some issues with the tools where the answers are present in the documentation are not properly resolved. Accurate description of credible problems encountered is not always seen.	Usage of the tools is shows a little awareness of the tools capabilities and features. Tools are used correctly and in a consistent way with the stated objectives. Improper use of the tools documentation. Several issues with the tools where the answers are present in the documentation are not properly resolved. Accurate description of credible problems encountered is missing.	Usage of the tools is shows no awareness of the tools capabilities and features. Tools are used incorrectly and in an inconsistent way with the stated objectives. Improper use of the tools documentation. Most issues with the tools where the answers are present in the documentation are not properly resolved. Accurate description of credible problems encountered is missing.

(n)The ability to design a system that involves the integration of hardware and software components

Outcome	Exemplary (4)	Proficient (3)	Apprentice (2)	Novice (1)
Selection of hardware equipment and software	Selection of hardware equipment and software follows a thorough approach where many criterions are used: performance, compatibility, standard compliance, protocol support, interoperability, manufacturer strength.	Selection of hardware equipment and software follows a thorough approach where few criterions are used: performance, compatibility, standard compliance. One or more relevant important criterions are ignored.	Selection of hardware equipment and software is based on the selection of a single manufacturer already integrated solution among several candidates.	Selection of hardware equipment and software is based on the suggestions of the marketing team of one single vendor
Integration Methodology	The integration methodology is well described and followed. Interfaces are well defined and their compatibility discussed. Use of an integration plan featuring integration phases and a test plan for each phase.	The integration methodology is well described and followed. Interfaces are mentioned but their compatibility is not considered. No use of an integration plan. Some mention of a test plan.	The integration methodology is not described properly and not always followed. Interfaces are not mentioned. No use of an integration plan. Tests are carried out without a plan.	An ad-hoc integration (No) methodology is followed but not described. No use of an integration plan. Tests are carried out without a plan.