**CHEG 482 –Group Design Project I**

**Department of Chemical Engineering**

**University of Waterloo**

**Calendar Description:**

In this course, students study the design process including: problem definition and needs analysis; process synthesis, process debottlenecking and troubleshooting; safety and environmental protection in design; written and oral communication for design reports. A significant portion of the term work will be devoted to a group design project, culminating in a design proposal that will be presented to the department. [Offered: F, S]

**Prerequisites or Co-requisites**

4A Chemical Engineering

**Instructor:**

***Prof. A. Elkamel***

**Office:** Room E6-3008 **Phone:** x37157 **Email:** aelkamel@uwaterloo.ca ; I check my e-mail almost daily and try to respond in a reasonable amount of time.

**Office Hours:**

Wednesdays - 11:20 a.m. – 12:30 p.m. [or by appointment]

Please realize that if you come to see me outside of office hours without an appointment, I may be committed to some other activity. Additionally I might not be able to give appointments on short notice.

Prof. Elkamel will have the primary responsibility for this course. Other faculty members and industrial partners will be called upon as resources for questions about your projects throughout the semester and will also be involved in the evaluation of final reports (oral and written).

**Scheduled Sessions:**

Fridays - 3:30 - 6:20 p.m. Room-E6-2022

We will meet on Fridays from 3:30 – 4:20 p.m. to return your graded assignments, check your progress, and discuss any issues you might have. The other time slots will be devoted for group meetings to work on your projects. All the background material for the course (problem solving, design methodology, etc.) will be posted on UW-Learn as a self-study material.

**Websites of Importance:**

I will be making frequent use of UW-Learn and will be sending e-mails quite often to the class. So make sure you make a habit out of checking UW-Learn and your e-mail.

*Additional Websites*:

* Chemical engineering design data, information and advice: <http://people.clarkson.edu/~wwilcox/Design/refs.htm>
* Turton textbook web site:

[**http://www2.cemr.wvu.edu/~wwwche/publications/processes/**](http://www2.cemr.wvu.edu/~wwwche/publications/processes/)

* Educational Material on Green Engineering:[**http://www.epa.gov/opptintr/greenengineering/pubs/educational.html#modules**](http://www.epa.gov/opptintr/greenengineering/pubs/educational.html#modules)
* Writing guidelines:[**http://www.writing.engr.psu.edu/**](http://www.writing.engr.psu.edu/)

**Course Objectives:**

The course is aimed at providing an opportunity to start the 4th year design project, which will be continued in Winter 2016. In this course, teams of students will propose potential new projects or process modifications. Students will work on project definition, literature searching, and preliminary analysis. Teams will identify potential solutions and will recommend a plan of action that will be presented in the form of a full Project Proposal. This aspect of the course is described in more detail later on in this document.

We will cover material of use to projects and professional practice including search strategies for technical information, technical writing and presentations, problem definition and solving strategies, process synthesis, analysis and optimization, energy management and integration, process troubleshooting, process hazards analysis, environmental management and safety in design. A short “Project Management” segment will also be provided by a guest lecturer with varied industrial-projects experience.

This course is your opportunity to demonstrate that you are prepared to enter the practice of engineering and can produce professional-quality work. All the professionalism required in the work situation will apply: you must meet all requirements on time, must be present for meetings with your group members and project supervisor (faculty member or industrial consultant), and must attend lectures and all presentations of other groups. Your overall grade will be mainly based on the assessment of these capabilities.

Course Learning Outcomes:

After completing this course, students will be able to:

* Perform a comprehensive literature search and screen out relevant and useful information (12).
* Apply problem solving heuristics/strategies to the design and analysis of chemical processes and products (2,3,5,11).
* Design and analyze chemical processes and/or products using fundamental principles of process and product design (4,11).
* Simulate unit operations, processes and simple plants (2,3,5).
* Carry out detailed design applying the best principles of environmental management and protection (4,9,11).
* Demonstrate an understanding of the principles and practice of safety, environmental, and ethical issues (8,9,10).
* Analyze safety concerns for process systems and apply best HSE practices for design of products, systems, and processes (8,9,10).
* Work effectively in a team set-up (6).
* Prepare posters, reports and make effective presentations (7).
* Develop a passion for self-study and lifelong learning (12).

**CEAB Graduate Attributes:**

The numbers in parentheses in the students learning objectives above refer to the CEAB Engineering Graduate Attributes defined by the Canadian Engineering Accreditation Board. These are listed below as a reference:

|  |  |
| --- | --- |
| **Outcome** | **Definition** |
| **1. A knowledge base for engineering** | Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.  |
| **2. Problem analysis** | An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.  |
| **3. Investigation** | An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.  |
| **4. Design** | An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.  |
| **5. Use of engineering tools** | An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations. |
| **6. Individual and team work** | An ability to work effectively as a member and as a leader in teams, preferably in a multi-disciplinary setting. |
| **7. Communication skills** | An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions. |
| **8. Professionalism** | An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.  |
| **9. Impact of engineering on society and the environment**  | An ability to analyze social and environmental aspects of engineering activities. Such abilities include an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society; the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship. |
| **10. Ethics and equity** | An ability to apply professional ethics, accountability, and equity. |
| **11. Economics and project management** | An ability to appropriately incorporate economics and business practices including project, risk and change management into the practice of engineering, and to understand their limitations.  |
| **12. Life-long learning** | An ability to identify and to address their own educational needs in a changing world to sufficiently maintain their competence and contribute to the advancement of knowledge. |

**Recommended Text:** “Analysis, Synthesis, and Design of Chemical Processes”, Turton, Bailie, Whiting and Shaeiwitz, Prentice-Hall PTR, 2002.

Course notes will be made available on UW-Learn.

**Other Useful references:**

“Strategies for Creative Problem Solving”, H.S. Fogler and S.E. LeBlanc, Prentice-Hall PTR, 1995.

 “Plant Design and Economics for Chemical Engineers”, Peters & Timmerhaus, McGraw-Hill (4th edition, 1991).

 “Analysis, Synthesis, and Design of Chemical Processes”, Biegler, Grossman Westerberg Prentice-Hall PTR, 1998.

 “Chemical Engineering Design”, R. Sinnott and G. Towler, Butterworths, 2010.

*A Guide to Writing as an Engineer*, D. Beer and D. McMurrey, 1997

*These references can be found in the Library.*

**Topics for the lectures will be drawn from the following list:**

1. Team dynamics and interpersonal relationships
2. Open ended problem solving strategies
3. Library search
4. Intellectual property and patents
5. Process Flowsheets and diagrams
6. Flowsheet balances with computers
7. Steps in product and process design
8. Process creation and Flowsheet synthesis
9. Written and oral communication for design reports
10. Project management
11. Environmental protection
12. Energy considerations
13. Safety considerations
14. Engineering ethics
15. Process Optimization

**Design Projects**

**Project Proposals:** Students are invited to propose their own design projects. Projects can be of three types: 1) Plant Design or Modification, 2) Product Design, or 3) General type projects (e.g. conducted in a lab at UWaterloo but must involve a design component). It is not necessary to have identified an industrial sponsor or faculty supervisor. The instructor will provide feedback on the project and will recommend a faculty supervisor if one is not identified. Group Size is 3 - 4 students. In some cases a group size of 5 may be permitted. Larger groups must have more than one clearly defined project scope. ‘Competition’ related projects are encouraged (see the course web site for some potential competitions). Joint projects with students from other engineering departments are possible (note that all departmental course requirements must be achieved).

**Project Selection:** Potential projects are encouraged to be based on your co-op experience. For projects involving plant design or modifications, at least one member of the group should have spent a co-op term in a plant related to the proposed project. Students are invited to form groups and select a project that is of interest to them. In cases where more than one group wishes to work on the same project, the faculty supervisor will alter the design requirements to make sure there is no duplication. ***Students have to finalize the selection of their project and supervisor/consultant (faculty member or industrial partner) by Friday, May 13, 2016. Please complete the project registration sheet and submit it to UW-Learn. This must be completed by 5:00 p.m. NOTE – this is an Engineering Design project and should involve several aspects of Engineering Design or Analysis (i.e. a ‘research’ project is not expected).***

**Project Execution**: The selected project is carried out under the supervision of the identified faculty supervisor or industrial partner. The project work is carried out under the following scenario: *Your team is bidding for project work for a “client”. A “Letter of Intent” is used to make the preliminary cut, and a formal Project Proposal is then submitted. The proposal is also presented and defended in an oral presentation. Other groups will be selected to act as the “client management”, and will be asked to review the strengths and weaknesses of the proposal. This is a team effort so plan and allocate the work across all members, meet regularly, and iterate the design concepts.*

**There are five main formal course requirements related to projects:**

1. **Letter of Intent/Transmittal**: This is a one page document that provides the project goals and specific objectives. The letter should describe the research to be conducted, any relevant preliminary study, partners, the design component of the project, and the length of the project. The letter should be signed by all members of the design team.
2. **Application of the Design Methodology**: This document (about 8-10 pages) should document the use of the design methodology to successfully implement your projects.

For Process Design, include:

1. A description of the product to be manufactured, including its chemical formula, and a discussion of the role of this product in the industry and its significance in national and international trade. A survey of the methods used in manufacturing this product, including the process being described in your project, giving the raw materials, the principal chemical reactions, byproducts, and intermediates.
2. An explanation of the choice of the production method. This often involves a description of partially synthesized flowsheets and the reasons why these flowsheets were rejected in favor of the design selected.
3. A discussion of the reasons for entering the market at this time.
4. An overview of the environmental issues encountered, including the toxicity of the chemicals, and the potential safety problems.
5. Process flow diagram, material balances, energy balances, and utility requirements (not in this assignment).

For Product Design, include:

1. Inform the reader about the nature of the product and the customer needs that it will satisfy.

2. Present the necessary background and approach that you will use to develop the product.

3. Discuss existing products that are similar to the new product that you propose to design:

- What are the main functions of the existing products?

- What product improvements would be welcomed and what has hindered the improvements?

- How and where are the existing products marketed?

- Are new markets possible if the nature of the products could be improved?

- What patents protect the existing products or possible future products?

4. List the specifications for the new product and delineate the differences between the new product and the existing products.

5. Present a list of all the ideas and concepts for the new product as generated by your team. It is preferable that the list be organized into several categories. Then the categories should be compared in an attempt to select the best one or two categories for further consideration.

6. Present the design of the new product or the recipe of the new product. Include all necessary details (not required for this report).

7. Present a proposed method/process for manufacturing the product. Ensure that all product specifications are met. To further broaden your design experience while you work on a project that involves only product design, I am also requiring you to design a preliminary process for making the new product. Therefore follow also some of the steps under process design above.

8. Discuss any potential adverse effects of the new product on humans or the environment.

9. Discuss the potential market for the new product.

10. Estimate selling price (not required at this time).

1. **Formal Project Proposal**: This document (about 25-30 pages) should contain:
* problem/project definition;
* a complete literature review;
* a preliminary work plan and task assignments for the group members;
* identification of any alternative solutions;
* results from preliminary calculations or flowsheets (e.g. block flow diagram and the detailed process flow diagram showing the material balance).
* the recommended strategy;
* work plan and task assignments for the remainder of the term and for the Winter 2017 term (CHE 483).

This report will be graded by the instructor, in consultation with the project supervisor/industrial partner.

1. **Project Presentation**: Groups will give a 10 minute presentation to “sell” the project and give their recommended course of action for the remainder of the term and for the Winter term (CHE 483). A grade will be assigned by the instructor considering input from the audience members.

Other assessment details are listed in the table below:

|  |  |  |
| --- | --- | --- |
| **Assignment** | **Nature of Assignment** | **Dates**  |
| **Assignment 1****Project Registration** | **Form (Filled Registration form ASAP please)** | **May 13**  |
| **Assignment 2****Literature Review on Project** | **3-5 pages report, plus reference list** | **May 20** |
| **Assignment 3****Letter of Intent** | **One Page Letter (hard copy is also required, one for the instructor and one for the project supervisor)** | **May 27** |
| **Assignment 4****Progress Report 1****(Design Alternatives)** | **3-5 pages report describing your progress working on your project: meetings conducted with project supervisor or industrial partner. This report should emphasize the design alternatives considered and the criteria used to select a "best" alternative.** | **June 10** |
| **Assignment 5****Progress Report 2****(Project Management)** | **3-5 pages report describing your progress working on your project: meetings conducted with project supervisor or industrial partner. This report should emphasize the project management aspects of the design.** | **June 24** |
| **Assignment 6****Progress Report 3****(Safety, Environmental, and Energy Aspects)** | **3-5 pages report describing your progress working on your project: meetings conducted with project supervisor or industrial partner. This report should emphasize safety, environmental, and energy considerations of the selected alternative.** | **July 8** |
| **Assignment 7****Progress Report 4****(Design Constraints)** | **3-5 pages report describing your progress working on your project: meetings conducted with project supervisor or industrial partner. This report should emphasize design constraints.** | **July 15** |
| **Assignment 8****Application of the Design Methodology to Project** | **8-10 pages report** | **July 22** |
| **Proposal Presentation**  | **10 minutes Power Point Presentation** | **July 27, July 28** |
| **Assignment 9****Proposal**  | **25-30 pages** | **July 29** |
| **Assignment 10****Progress Report 5** | **3-5 pages report describing your progress working on your project: meetings conducted with project supervisor or industrial partner. This report should emphasize what you have done since submitting the proposal.** | **August 25** |
| **ChE 483 (Winter Term)** | **Conduct Group Design Project II** |  |

(format is generally 12 point font 1.5 line spacing, submitted to UW-Learn)

Each assignment file must be titled **Group [#XX] - Assignment \*\* – ChE 492**

Please load your assignments and projects to UW-Learn in the appropriate drop box. ***Files must be in MS Word Format or power point format*** (for presentations).

**NOTE:**There are a number of awards and competitions available. If you intend to participate in such competitions please talk to me and we can discuss with your faculty supervisor how deliverables can be modified/tailored for your competition.

**Evaluation:**

This course is a mix of online lectures and group project activities. Because much of the learning occurs in group activities and workshops you will get little from this course if you do not attend and participate in your group activities and meetings. Many components contribute to the overall student assessment in this course. The assessed components are:

|  |  |  |
| --- | --- | --- |
|  | **ChE 482****Assignments Plus In-Class Work** | **Maximum Marks for Assignments** |
| Assignments will be graded using the rubrics provided.  |
| Project Registration | Filled Form | 10 |
| Literature Review on Project | 3-5 pages report, plus reference listLiterature from different types of materials (Web, Journal, book, patent, Conference proceeding, Master's Thesis, etc.) to demonstrate you can find information.Must show depth and breadth. References that provide general background information on your project and references that are very specific must be surveyed. Can be like a literature review in an academic journal article.No cover page or table of contents are needed BUT it should be a presentable engineering document. It should be 2-3 pages (1.5 spacing) in length. | 20 |
| Letter of Intent  | 1 page | 70 |
| Progress Reports 1 - 5 | 3-5 pages reportsDescribe your progress on the project so far. Meetings conducted with your supervisor or industrial partner. For each report emphasize the aspects discussed in class and as mentioned on pages 7 and 8. | 20 each |
| Application of the Design Methodology to Project | 8-10 pages reportOutline the basic Design Methodology (including the use of engineering design tools), and explain how your team addressed, or will address, each step of the process. | 50 |
| Proposal Presentation  | 10 minutes Power Point Presentation | 150 |
| Proposal | 25-30 pages | 350 |

**Notes:**

1. Participation in a Competition will earn you a 1–5% Bonus (e.g., AIChE Design Contest, or propose another competition). Bonus is a function of additional competition responsibilities during the term. The bonus will be applied towards your CHE483 grade.
2. For projects related to product design, the requirements are different from the ones stated above (e.g. we do not speak about process flow diagram and material and energy balances). Some of the specifics for this kind of projects are:
	* Nature of product and customer needs that it will satisfy.
	* Necessary background approach used to develop the product.
	* Relation to existing similar products: main functions of existing products, product improvements, how are existing products marketed, are new markets possible, patents that protect the existing products or possible future products.
	* Product specifications for the new product and the difference between the new product and the existing products.
	* Idea generation and concepts for the new product as generated by the design team. Organize the list into several categories and compare the categories in order to select the best one or two for further consideration.
	* Selection of best concept based on supporting calculations to prove the workability of the concept.
	* Architecture design of the new product complete with appropriate sketches.
	* Development of a working prototype of the product, testing procedures, and an assessment of the superiority of the product over current competitors
	* Proposed methods for manufacturing the product ensuring that product specifications are met.
	* Potential adverse effects of the new product on humans or the environment.
	* Marketing of the new product and cost estimation (including selling price and potential markets)

**Ground Rules and Academic Integrity:**

* Students are responsible for the lecture materials, assignments, and announcements made on UW-Learn. Students are expected to make up any work missed due to absences. Excuses (e.g. a doctor’s note) must be brought to the instructor immediately to qualify for permission to make up work missed. All excuses must first be authenticated by Student Affairs.
* Student assignments must be submitted on the due date to receive credit. Student assignments submitted 24 hours or less after the due date will receive a 30% deduction, a 24 – 48 hours delay will receive a 60% deduction, and a delay of more than 48 hours will receive a zero credit. Students late for group presentations, for their own presentation or the presentation of another group will receive a grade of zero on the presentation.
* Regrading Policy:If you feel that you did not receive appropriate credit on an assignment, request a re-grade within three days of the time when the graded material was returned to you. Write your grading concern on a piece of paper, attach it to your work and return it back to me.
* Religious Observances: Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please let your instructor know of any conflict at least two weeks in advance.
* Students with Disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.
* Academic Honesty: Students are expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offence, or who need help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, TA, academic advisor, or the Undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy #71, Student Academic Discipline. Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy#70, Student Grievance .

***Ending Notes:***

*I would like to note that I as well as your project supervisor are here to help you. Please feel free to ask for assistance if you should require any.*

*May you enjoy this course as effort will be put forth to see that you have a positive experience.*

## ChEG 482 Project Registration Form Spring 2016

This form must be completed and agreed upon by your Main Project Supervisor. Load the form to UW-Learn before 5:00 p.m. on **Sept 21, 2015.** Projects will be reviewed by the ChE482 instructor **AFTER** you have submitted them. You will be contacted if there is any problem with your project.

##### Student’s Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ID No.: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

##### Student’s Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ID No.: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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##### Student’s Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ID No.: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

#### Supervisor’s Name(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Project Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**Project Goals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**ChEG 482 Final Proposal Presentation Evaluation Form Spring 2016**

|  |  |  |
| --- | --- | --- |
| Date: | Student/Group’s Name: | Evaluator: |
| ProjectTitle: | Signature: |
| Project #: |
| **Category** | **Typical Criteria for Judging Quality****(Please explain A++ and F grades)** | **A++** | **A** | **B** | **C** | **D** | **F** | **Mark** |
| **Out-standing** | **Excel-lent** | **Good** | **Satisfactory** | **Marginal** | **Failure** |
| **Problem Definition** | Clear, concise presentation of problem or project. Knowledge and consideration of relevant background material and issues. | 3.0 | 2.7 | 2.4 | 2.1 | 1.5 | 1.2 |  |
| **Design, Analysis, or Experimental****Process Overall Accomplishment** | Demonstration of appropriate methodology and approach to the proposed project Has performed suitable analysis background review. This should include consideration of safety and environmental impact.(Consider the size of the group). | 6.0 | 5.4 | 4.8 | 4.2 | 3.0 | 2.4 |  |
| **Feasibility/Application/ Utility**  | Has demonstrated feasibility, application or utility of proposed projectIs the project achievable? | 2.0 | 1.8 | 1.6 | 1.4 | 1.0 | 0.8 |  |
| **Clarity of Presentation** | Clear, concise presentation and ability to respond to questions.Good graphics, presentation style | 4.0 | 3.6 | 3.2 | 2.8 | 2.0 | 1.6 |  |
| **Peer Evaluation** |  | 5.0 | 4.5 | 4.0 | 3.5 | 2.5 | 2.0 |  |
|  | Out of | 20 |  |  |  |  | Total: |  |

**Comments:** Please explain, very briefly, your reasons for assigning grades in the highest (A++) and lowest (F) categories.

**ChE 482 Proposal Evaluation Form Spring 2016**

|  |  |  |
| --- | --- | --- |
| Date: | Student’s Name: | Evaluator: |
| ProjectTitle: | Signature: |
| Project #: |
| **Category** | **Typical Criteria for Judging Quality****(Please explain A++ and F grades)** | **A++** | **A** | **B** | **C** | **D** | **F** | **Mark** |
| **Out-standing** | **Excel-lent** | **Good** | **Satisfactory** | **Marginal** | **Failure** |
| **Project Goals**  | * Is the Proposed Project well defined and have realistic and clear goals?
* Is there a budget and milestones?
* Is the team and individual responsibility outlined?
 | 5 | 4.5 | 4 | 3.5  | 2.5 | 2 |  |
| **Design****Methodology** | Are design principals demonstrated:* Options considered , evaluated, and screened
* Safety and Environmental considerations discussed
* Potential project difficulties identified
* Costs considered
* **Design constraints discussed in details**
 | 10 | 9 | 8 | 7  | 5 | 4 |  |
| **Professional Integrity, Ethical Responsibility, and contemporary issues** | * Group demonstrates an ability to make ethical choices.
* Evaluation of the ethical dimensions of the project outlined.
* Group demonstrates an awareness of professional integrity.
* Socio-economic and environmental issues addressed.
 | 5 | 4.5 | 4 | 3.5 | 2.5 | 2 |  |
| **Impact of Solution in a global, economic, and societal context** | * Demonstrates understanding of the complete life-cycle of the process/product
* Global effects of process/product explained.
* Economics factors discussed.
* Implications of solution on society at large discussed.
 | 5 | 4.5 | 4 | 3.5 | 2.5 | 2 |  |
| **Creativity and Initiative** | Creativity and initiative demonstrated by the students. | 5 | 4.5 | 4 | 3.5  | 2.5 | 2 |  |
| **Report Quality and Content** | Report Format (appearance, spelling, grammar, structure) | 5 | 4.5 | 4 | 3.5  | 2.5 | 4 |  |
| Clarity of Communication | 5 | 4.5 | 4 | 3.5  | 2.5 | 2 |  |
| Analytical / Research or Experimental content Overall Group Effort and Work Accomplished | 10 | 9 | 8 | 7  | 5 | 4 |  |
|  |  | 50 |  |  |  |  | Total: |  |

**Comments:**