What is the Capstone Design Project?

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Topics

- Capstone Design Project: concept
- Capstone Design Project: defined
- Design Project Criteria
- IE Senior Capstone Design Project
- Capstone Design Project Learning Objectives and ABET Outcomes
- Grading of design project
- Project Selection Procedures
- Capstone Design Project Proposal Form
Capstone Design Project: concept

- It is a strategic course & a Mandatory in accredited engineering program.
- It provides senior engineering students open-ended project experiences with a variety of realistic requirements and constraints.
- It makes excellent environments for observing, cultivating, and documenting students’ professional competencies and their achievement in support of program accreditation.

Capstone Design Project: concept

The capstone design course is a forum where the non technical as well as the technical aspects of success in an engineering career can be highlighted.

It is a way to challenge our students to develop their full range of skills, to be better engineers.
Capstone Design Project: concept

• The capstone design course is not just about finding a technical solution to a particular problem

but it is about

How can Student Work as Engineer Within A Project

Capstone Design Project: concept

• One of the keys to make this happen is

- rewarding the students for excelling in all aspects of the course
- not just grading their technical solution.
- The reward system must match the wanted behavior!
 capacstone Design Project: defined

- **What is a capstone?** It means linguistically
  The crowning achievement (top stone of a structure)

- **What is Design?** It means
  “An ability to design solutions for complex, open-ended engineering problems for systems, components or processes that meet specified needs, considering realistic constraints such as applicable standards, health and safety risks, economic, environmental, cultural and societal, manufacturability, and sustainability”

Capstone Design Project: defined

- **What is Project?** It means
  “An undertaking requiring concerted effort to create a unique work”
  (An extensive task undertaken by a student or group of students to apply, illustrate, or supplement classroom lessons)

- **What is Capstone Design Project?** It means
  “An undertaking a project work of a real-world, open-ended, and interdisciplinary engineering problems and applying lessons learned in realization and visualization of engineering problem, defining the problem and its functional requirements, project planning, engineering design process, selection between alternatives, analysis, identifying risks and countermeasures, and physical prototyping”.

Capstone Design Project: defined

Capstone design project is concerned with 5 elements:

- **(Project planning)**, Ability to plan and execute a project
- **(Problem/project definition)**, Ability to address an engineering situation
- **(Engineering design)**, Ability to find design alternatives and to select optimally and effectively within realistic requirements and constraints
- **(Team work skills)**, Ability to work within team building meeting skill, and conflict resolution.
- **(Communication skills)**, Ability to communicate in writing and orally building the communication, presentation, and interpersonal skills.

Design Project criteria

- Capstone design project is built on several design criteria based on:
  - ABET and
  - Professional Institutions.
Design Project criteria

• **ABET Criterion 3c:**
  • An ability to design a system, component, or process to meet desired needs within realistic constraints such as:
    - economic,
    - environmental,
    - social,
    - political,
    - ethical,
    - health and safety,
    - manufacturability, and
    - sustainability.

*Industrial Engineering criterion for IE Program*

*(Institute of Industrial Engineering)*

“The ability to design, develop, implement, and improve integrated system that includes people, material, information, equipment and energy using appropriate analytical, computational, and experimental practice”.
Design Project criteria

- **Manufacturing criterion for program include manufacturing** (Society of Manufacturing Engineers)

“The ability to design, process, assembly, product, equipment, tooling, systems and environment for manufacturing using and understanding knowledge of manufacturing planning, strategy, and control. (Understanding the analysis, synthesis, and control of manufacturing operations using statistical and calculus; simulation and information technology; laboratory experience”).

Design Project criteria

- **ABET Criterion 5:**
  - Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on:
    - the knowledge and skills acquired in earlier coursework, and
    - incorporating appropriate engineering standards and multiple realistic constraints.
IE Senior Capstone Design Project

• Based on the above criteria:
  • Design projects are design tasks for production systems and its components (manufacturing or service). They are based on Analytical and/or Experimental Base

  The design tasks can be one or more of the following elements:
  • A process/procedure,
  • Product,
  • A component, or
  • A system

IE Senior Capstone Design Project

• Project background (figure 1):
  • Knowledge gained from the previous engineering sciences, design and laboratory course works.
  • Modern tools and techniques in the fields of IE

Science and mathematic courses, (12+23CH)
CHEM101, PHYS103, PHYS104, MATH140, MATH150, MATH107, MATH203, MATH204, MATH244, STAT324

General engineering courses, (15CH)
GE104, GE201, GE211, GE302, GE403, GE404

Engineering sciences courses and design components, (46CH)
IE214, IE222, IE251, IE252, IE314, IE322, IE333, IE337, IE339, IE341, IE36, IE405, IE409, IE438, IE446, IE462

Engineering design courses, (17CH)
IE301, IE342, IE360, IE450, IE461, IE469

Figure (1) IE program leading to capstone design project
IE Capstone Design Project

- The project is given by two sequential courses
- IE 496: Project -1-; 2(1,1,2); 9th semester
- IE 497: Project -2-; 2(0,1,4); 10th semester

IE - Capstone Design Project
Learning Objectives and ABET Outcomes

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King Saud university
IE 496 Project - 1 -

This part of the project prepares the senior students to carry a production design project for process, product, component, and/or system on the basis of the learned knowledge as follows:

- Selecting a design project topic;
- Identifying the problem;
- Developing work plan;
- Formulating the problem through reviewing background and integrating knowledge;
- Preparing for/or preliminary conducting of the experiments;
- Collecting the field data and developing the mathematical model if applicable;
- Writing the first part along with any preliminary findings.

IE496 Project - 1 -

Learning Objectives (LO) and ABET Outcomes

It is a preparatory stage: background, problem definition, problem formulation, and work plan (8LO)

- **LO1**: Background review; ABET Outcomes: a, e
- **LO2**: Project identification and selection; ABET Outcomes: e
- **LO3**: Problem formulation; ABET Outcomes: e
- **LO4**: Design objectives and evaluation; ABET Outcomes: e
- **LO5**: Project planning; ABET Outcomes: e
- **LO6**: Work attitude (a) Contribution to work and Taking responsibility; (b) Valuing other views and Conflict resolution; ABET Outcomes: d, f
- **LO7**: Written communication skill (a) Style, Formatting, Organizing & language neatness; (b) Contents & References; ABET Outcomes: g, k
- **LO8**: Oral communication skill (a) Style, Organizing, Visual aid & neatness; (b) Delivery skill & Audience response; ABET Outcomes: g, k
This part of the project, the senior students implement a production design project for process, product, component, and/or system on the basis of the learned knowledge as follows:

- Selecting appropriate design and/or experimental tools;
- Performing design/experiments;
- Performing analysis and evaluation of result;
- Interpreting and conclusions of results;
- Recommendation and future work

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**Learning Objectives (LO) and ABET Outcomes**

*It is the Implementation stage*: Implement a planned design strategy for either an experimental or a production-based design project or both (8LO)

- **LO1**: Implementing project parameters and assumptions; ABET Outcomes: c, and/or b
- **LO2**: Design analysis and/or experimental design; ABET Outcomes: c, k
- **LO3**: Use modern engineering tools to estimate and/or to explain a reliable experimental setup for obtaining the performance parameters and trade-off studies and a final optimized analysis; ABET Outcomes: c, k
- **LO4**: Evaluation of relevant constraints in particular environmental and health issues; ABET Outcomes: f, h, i
- **LO5**: Evaluation of analysis of design criteria; ABET Outcomes: h, j, c and/or b
- **LO6**: Work attitude (a) Contribution to work and Taking responsibility; (b) Valuing other views and Conflict resolution; ABET Outcomes: d, f
- **LO7**: Written communication skill (a) Style, Formatting, Organizing & language neatness; (b) Contents & References; ABET Outcomes: g, k
- **LO8**: Oral communication skill (a) Style, Organizing, Visual aid & neatness; (b) Delivery skill & Audience response; ABET Outcomes: g, k
IE - Capstone Design Project

Grading of the design project

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Grading of the design project

- **Semester Grading (100 marks)**
  - Supervisor(s) set weekly group meetings to follow up project progress and assess student according as follow:
    1. Student absenteeism *(will be collected weekly by project coordinator). Student absent over 25% will be barred*
    2. Setting at least one written quiz. (10 marks)
    3. Students submit at least one progressive report. (10 marks)
    4. Assessment of student outcomes by filling an assessment form
      - For Project Learning outcome **LO1 to 5** (50 marks)
      - For Project Learning outcome (work attitude) **LO6** (20 marks)
    5. Students self assessment (10 marks)
Grading of design project

**Final Grading (100 marks)**

1) **Two examiners** fill assessment forms and **submit to project coordinator before oral representation.**
   
   a) Examiner evaluation of learning outcomes **LO1 to 5** (50 marks)
   
   b) Examiner evaluation of the written communication learning Outcome **LO6** (20 marks)
   
   c) Examiner project evaluation as capstone design project (10 marks)

2) **Student set for oral representing the work using PowerPoint.** Examiner evaluation of the oral communication learning outcome **LO7-8** (20 marks)
IE - Capstone Design Project

Selection Procedures and proposal form (PPF)

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Project Selection Procedures

1. Submit a project proposal (in English).
2. The project proposal is evaluated.
3. A list of approved projects is published.
4. The project is finalized and implemented.
5. The project is evaluated.
6. The project is approved.
7. The project is presented at the final presentation.

Steps:
- Project Selection
- Project Implementation
- Project Evaluation
- Project Approval
- Final Presentation
Project Proposal Form (PPF) Content

- **Project Title:** suggest title for the project (make it as short as possible)
- **Contact:** The name of the contact or mentor for the student team. If the project is for a company please include that information.
- **Background:** Brief explanation of the project, the needs, and drivers for this effort.
- **Objective:** What is to be accomplished in the project?
- **System Requirements:** state in broad and simple terms. The specific details will be established between the client and the team.
  - 1)
  - 2)
**Project Proposal Form (PPF) Content**

- **Deliverables**: indicate the desired deliverables in the project. The final deliverables will be established through negotiations between the team and the client.

- **Technical Requirements**: suggest the skill areas the students may need in order to complete the project.

- **Customer Commitments**: state the expected commitments to make available to ensure successful completion of the project.

- **Realistic Constraints**: state the expected constraints to be addressed

- **Additional Requirements**:

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- **Project Proposal Form (PPF) Content**

- Staff should fill the form and after team is assigned; the project should explained in details to students.

- At start the students should carry out the following by mentor help;

  1. **Project planning activity**: to provide a work plan as Gantt chart

  2. **Explain how this project would address the ABET requirements of incorporating engineering standards and realistic constraints in these areas**
## Example of Realistic Constraint

<table>
<thead>
<tr>
<th>Area</th>
<th>Codes &amp; Standards / Realistic Constraints</th>
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<tr>
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