# COURSE Project (15%)

2020-2021

***Feedback System Analysis and Design***

***EE382***

Semester: Summer 2021

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## I. Introduction

Projects for engineering students give an edge over the race of recruitment to work hard to ensure a good career. In spite of employment practices in recent times, students are progressively taking up projects to pad up their skill-set. Engineering projects help students to learn and acquire practical knowledge. Despite of theory concept they acquire, various industries also need to know their capacity to complete projects using their specific initiatives. Thus, we recommend students to realize engineering projects in their four years of engineering and try to present as many white papers as possible. Students who give importance to their course projects are expected to learn how to:

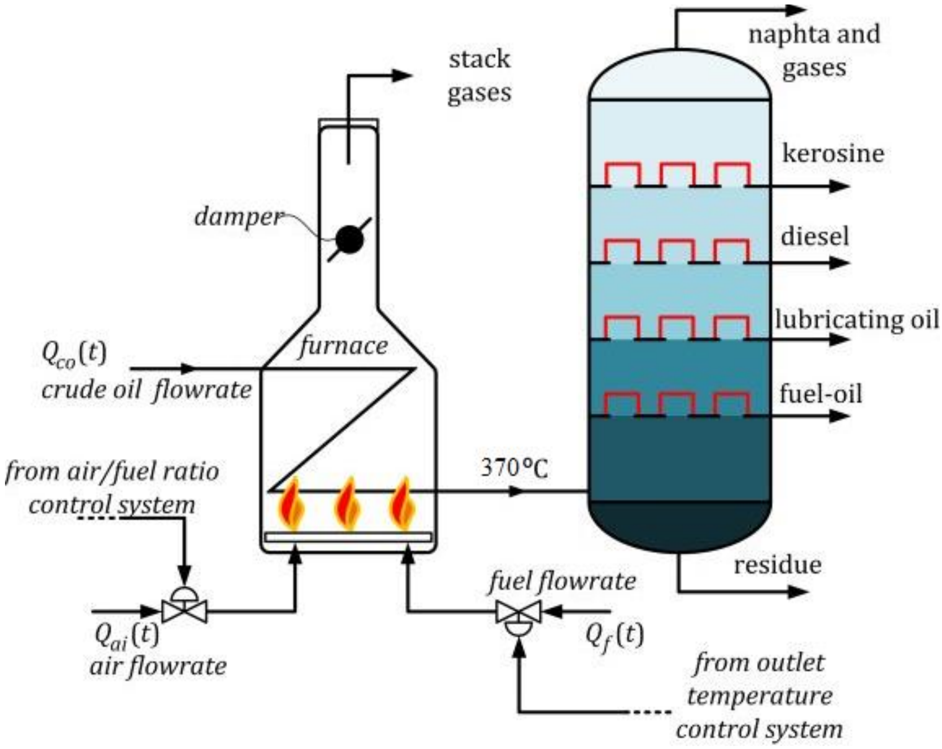
- Work in teams including multidisciplinary teams
- Build a major design experience based on the knowledge and skills acquired in the course work
- Build a major design experience incorporates appropriate engineering standards and multiple realistic constraints
- Apply both analysis and synthesis in the engineering design process, resulting in designs that meet the desired needs

In the design process, both creativity and criticism are essential. The followings are the seven steps that students should consider while designing their projects:

- Recognition of the need and identifying opportunities: Every project begins with recognition that needs improvement. These needs may be obvious or hidden to be revealed by investigation, surveys or research.
- Definition of the design problem: It is a major task requires gathering information about the problem.
- Definition of the design criteria and constraints: While the problem is being defined, the design criteria and constraints must be defined
  a. Design criteria are performance standards to be met by the design
  b. Design constraints are limitations placed on the designer, the final design or manufacturing process. *Examples of possible constraints include accessibility, aesthetics, codes, constructability, cost, ergonomics, extensibility, functionality, interoperability, legal considerations, maintainability, manufacturability, marketability, policy, regulations, schedule, standards, sustainability, or usability*.
  c. Risk analysis
- The design loop: design is a repetitive process of:
  a. Synthesis (Brainstorming - Generating new ideas)
  b. Analysis (Breaking ideas – find expected results)
  c. Decision-making (Deciding the best alternative)
- Optimization: Design team must ask themselves if it is the optimum design. Optimum is the best design that can be achieved at reasonable cost. The proposed design is judged against the design criteria
- Evaluation: Design team should hold a design review to approve drawings and specifications before they are released. If an optimum design cannot be achieved, the design team might revise the problem definition, the design criteria or the constraints in order to achieve the optimal solution or prototype.

## II. Project Description

You are working in a team whose main job is the control of a crude oil preheating furnace shown below:




Currently your team is struggling with a technical issue that is:

The Transfer function of the system is unknown, and by injecting one unit of the fuel flowrate to the open loop system, the crude oil preheating furnace behaves as shown below:

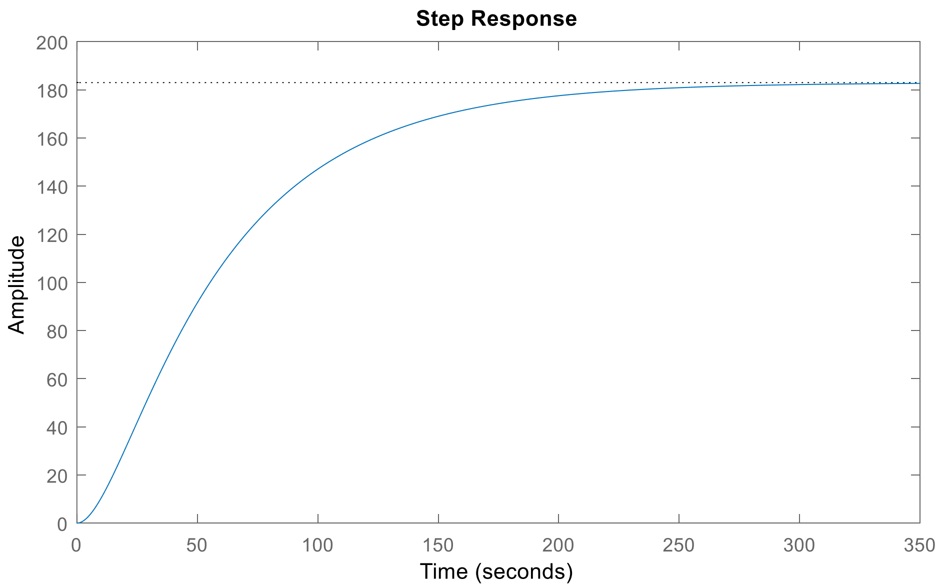



*Figure 1: Step response of the open-loop system*

Then, when injecting one unit of the fuel flowrate as a reference to the close loop system, the crude oil preheating furnace behaves very unsteadily as shown below:

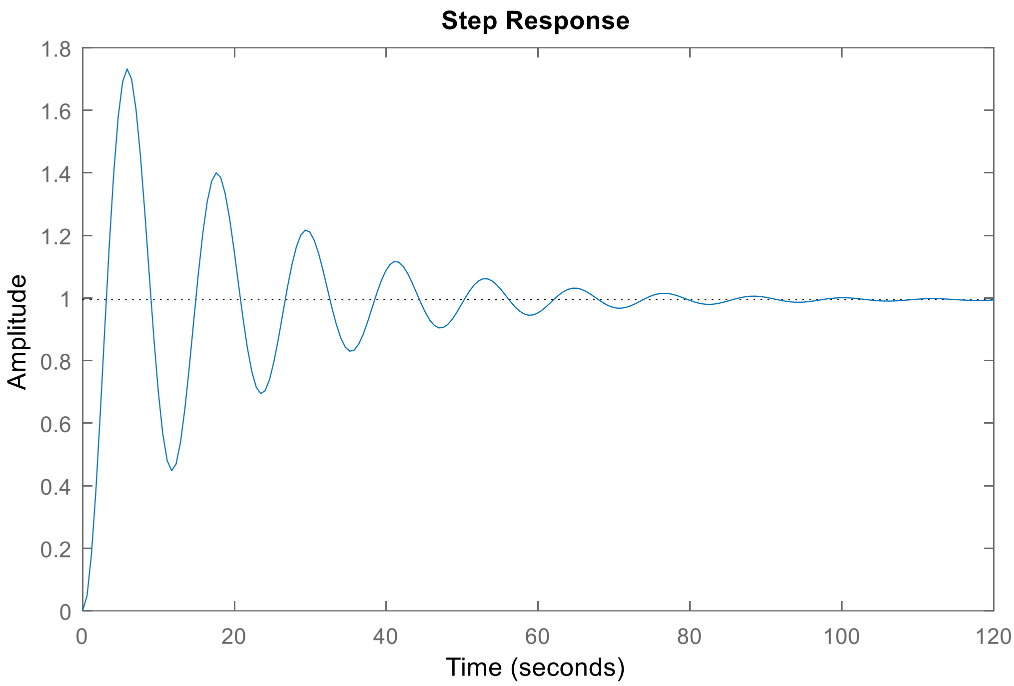



*Figure 2: Step response of the close-loop system*

This is not acceptable as the target temperature of crude oil preheating furnace should be around 370 $^0$C. In addition, the temperature cannot exceed 20 degrees more than few occasions. If repeated, the furnace would be damaged permanently.

You are asked to design a PID controller for the system **using MATLAB/Simulink**.

The developed Simulink system should have the following parts:

a. PID controller

b. System

c. Feedback

The design of your PID **should be tuned** in order to guarantee the best performance.

*The process of installing a free trial version of MATLAB will be explained in class.*

## III. ABET Learning Outcome

The aim of this project is to

a. Obtain mathematical models of electrical and mechanical systems [1].
b. Perform stability and sensitivity analyses of linear time-invariant feedback

systems [1].

c. Design a controller to meet specifications in time and frequency domain [1,2].
d. Use computer-aided tools for control system analysis and design [1,2].
e. Function on multidisciplinary team to attain the ability of [3,4,5,7]:
   - Acquire and apply new knowledge as needed, using appropriate learning strategies.
   - Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
   - Communicate effectively with a range of audiences.

## IV. Project Management & Deliverables

This project is written in one deliverable.

### Project report (due date is week 6):

- Students of each class need to form project groups (group of 3)
- Students are required to propose a design regarding the project which includes a detailed description of the PID tuning and related simulation results. Also, the full schematic for the block diagram should be provided along with a description of the control system operation. A complete design includes the following:
  - ✓ The Transfer Function of the whole system including PID controller.
  - ✓ Detailed stability and error calculations.
  - ✓ MATLAB Simulink results to auto-tune the PID controller parameters.
- A scientific report must be written and submitted. The provided template should be used. The report should begin with a discussion of system architecture. It should contain the same headings as in the template, with more details given. In the conclusions, discuss the difficulties encountered, changes you would like to make, and lessons learned from the project.
- The report should include the complete analysis of the project
- Students should clarify the followed learning strategy in order to get an optimum solution and design of their work.
- Each group must perform the simulation to tune the PID controller, and the results should be included in the report, to show and explain the operation and the function of each part of the project.

## V. Turnitin

Turnitin is a web-based solution that lets AUM faculty and AUM students check written work for improper citation or misappropriated content. You may be assigned a username and a password to be able to upload your assignments online, when and if requested. If you face any technical problem, please contact IT at AUM.

## VI. APA Style

AUM adopts the APA writing style for all its academic programs. AUM students need to use this style for their assignments. The following web site is of value for students: http://owl.english.purdue.edu/owl/resource/560/01/. Students are also encouraged to visit the AUM Writing Lab to receive help and guidance on all APA-related questions.

## VII. Academic Honesty and Integrity Assurance

One of the signs that the course material has been properly understood is honesty when accomplishing the assignments. Lack of academic integrity (e.g. plagiarism, copying another person's work, the use of unauthorized aids on examinations, cheating, facilitating acts of academic dishonesty by others) will not be tolerated. Therefore, if students include ideas, sentences, or other material that are not theirs in their work, they must properly quote the source(s). Students are encouraged to consult with the instructor if they have any questions on the issues of academic integrity or technical formatting of the references.

**Upon suspicion and doubt of the authenticity of the work submitted, the Instructor has the right to ask the student to verify her/his work. This can be done through, but not limited to, repeating the work, oral examination or discussion, alternative or similar on spot class assignment, pop quiz, or any other action deemed necessary. If the student fails to prove the authenticity of the work, then the Instructor will apply the academic misconduct rules as mentioned in the AUM Student Handbook which may include awarding the work a zero grade.**

Students are expected and encouraged to be honest and to maintain the highest standards of academic integrity in their academic work and assignments at the University. Any act of Academic Dishonesty may result in severe consequences for violations range from zero grades given for the assignments, failing the course, and suspension from the University. Students will refrain from any academic dishonesty or misconduct including, but not limited to:

- Upon suspicion and doubt of the authenticity of the work submitted, the Instructor has the right to ask the student to verify her/his work. This can be done through, but not limited to, oral examination or discussion, or any other action deemed necessary. If the student fails to prove the authenticity of the work, then the Instructor will apply the academic misconduct rules as mentioned in the AUM Student Handbook
- A zero grade will be given to all students that share exactly the same results: You will also be held responsible if someone else copies your work - unless you can demonstrate that you have taken reasonable precautions against copying.
- Any violation of the AUM standards will be taken as a violation to AUM policy and can lead to penalties. If you wonder whether a course of action violates this policy, simply ask in advance and please refer to the undergraduate AUM Student Handbook.

***For a detailed description of academic misconduct, please refer to the AUM Student Handbook.***

## VIII. Copyrights

Students are expected to adhere to copyright practices, **refer to the undergraduate AUM Student Handbook.**

## IX. Project and team-based work

The Project component of the course, if exist, is essential to passing this course. The project shows competency in understanding and applying the course objectives and achieving the learning outcomes. The project should allow the student to investigate, apply, research, and practice real-life business situations. It is expected that each student to fully and actively participate in the project as an effective team member. A project document will be distributed later in the semester with details about the project.

For all group related work, the <u>entire team is responsible for the team outcome and the deliverables</u>, except for the specific parts of the project that may be graded individually depending on the project's requirement and as communicated in the project document.

## X. Marking Scheme

The project is worth 15% of the total grade of your course. The grade will be based on every group's work, analysis and simulation. The student will be evaluated based on the below grading scheme:

### <u>Deliverable 1:</u> Final Report (15%)

| Introduction (20%) | Proposed Solution, PID construction and simulation (40%) | Conclusion (10%) | References (5%) | Formatting and language used (25%) |
|---|---|---|---|---|
| • Problem Definition (8%)<br>• Objectives (7%)<br>• Structure of the Report (5%) | • Background and Theory (5%)<br>• Steps of building the simulations with pictures of final prototype (15%)<br>• Discussion/ Simulation/ Code correctly follows the flowchart/ block diagram (20%) | • Summary of the work done. (5%)<br>• Future work. (5%) | • Use IEEE or APA references | • Grammatical and sentence structural mistakes (15%)<br>• Formatting: Cover page, group members' names, consistent fonts and size throughout the document (i.e. no copy-pasting from the net) (10%) |

## XI. Student Assessment Rubric

| Deliverables | Bare pass mark (60%-69%) | C classification (70%-79%) | B classification (80%-87%) | A classification (>87%) |
|---|---|---|---|---|
| Engineering design Process<br><br>Weighting (15%) | • The design process covers all possible stages.<br>• The design analysis could include some mistakes | • The design process has to be correct with all stages correctly described<br>• The design analysis is satisfactory | • The design process has to be correct with analysis to the proposed solutions<br>• The design analysis is good and the design chosen should fit at least 2 project requirements | • The design process has to be correct with full analysis to the proposed solutions besides showing evidence<br>• The design analysis is excellent and the design chosen should fit all project requirements. |