Dept. of Mechanical Engineering,
  College of Engineering,
   Taibah University

SEM 2, 1442 (2020/2021)
ME 443 System Dynamics & Control Lab
Project, Time: 5 weeks

Project [20 marks]:

ME 443 project objectives are:
1- To design a controller of a system through simulation applying MATLAB and/or any other software package.
2- To analyze a system behavior with and without control.
3- To select the suitable components, including their characteristics, for implementing the system.
4- Enhancing students' capabilities in transformative learning, team working and soft skills.

Each group, as announced is required to select a title from the following:
a- Vibration control of a cantilever,
b- Temperature control of a heated isolated rod,

Hints:
1- For the stated titles, it is possible to use a similar structure of lab experimental system with same parameters' values. Prototyping needs implementing another one on a small scale.
2- It is possible to use another title on the condition that you are planning to implement a prototype.

Students are advised to work in the project (in groups online). Please use the time allocated for the lab session during slot times prescribed in your lab schedule. You would better introduce your work in the project report as follows:

1. **Introduce** a system you wish to design its controller:
    i.   State the title of the project.
    ii.   Introduce the plant, the input and output variables, the actuator, the sensor, and the controller.
    iii. State the different applications of the system.
    iv.   State why did you choose the title.

2. **Mathematical modeling**:
    i.   Introduce the mathematical model of the system, (state the references if extracted from some resources). Keep in mind that you should understand what you are extracting.
    ii.   Linearize the model if there are nonlinearities.
    iii. Obtain its transfer function.

3. **Analyze the system in time domain**, (applying MATLAB or other simulation packages):
    i.   Show the time response for a unit step input (or the closest type of input to the system you have selected in reality)
    ii.   Analyze the performance of the system and show the performance specification(s) required to improve and its(their) objective(s)

4. **Suggest a controller** (i.e., P, PI, PD or PID) that would improve the performance of the system. **Justify your choice (state the cause of your selection).**

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5. **Show the step response of the system under control** with the suggested controller.
   i. Find the different performance parameters (i.e. settling time, peak overshot, steady state errors…..etc.)
   ii. Discuss if the performance is satisfactory.

6. Repeat step 2 to 5 if needed until the performance becomes satisfactory.

7. Select the components needed to build a prototype including their characteristics.

8. Conclude your project.

Hint: bonus marks up to 10 will be given to successful lab-built project prototypes.

Students are required to present the items from 1 to 6 above in a report (10 pages maximum). Introducing the results in a report will evaluate students' capability in: **Teamwork, Controller Design, System Performance Analysis, Writing Capability and Application of MATLAB.**

Report submission deadline (online):
8 April 2020 at 23:59 O'clock. Late submitted reports will have deduction of one mark/hour. Submission will be through the blackboard system. If noticed, copied/illegal reports will be given a negative mark that may reach -20 marks.

Discussion: each group should prepare a 15-minutes presentation including the main features of the submitted report. Each student will be judged for his done work as well as his understanding of other group members work.

Discussion time: during the lab sessions as announced in the schedule. Detailed time schedule for groups in each lab session will be announced later.