COURSE PROJECT

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Project Requirements:

- You can work in pairs of two. Not more than two students per project. You can also work on your own if you prefer that.
- Your solutions should be typed into a clear document. Usage of full sentences with clear meanings is **mandatory.**
- You should use MATLAB as much as you can, as this might help you with the project solutions.
- You should include the codes used. If you want to save a figure from MATLAB, don't take screenshots—save the file as .PNG or other extensions.
- Your grade will be determined based on the report and the way you present the solutions. You might also want to do some research on how to design a system if one of the ideas was not covered in class.
- You should first consult with the TA first if you have any questions.
- You can follow any approach in the design of the controller. A more rigorous approach will get a better assessment in comparison with a brute-force approach.
- Project submission deadline: **April 26th @ noon**.

Project Description:

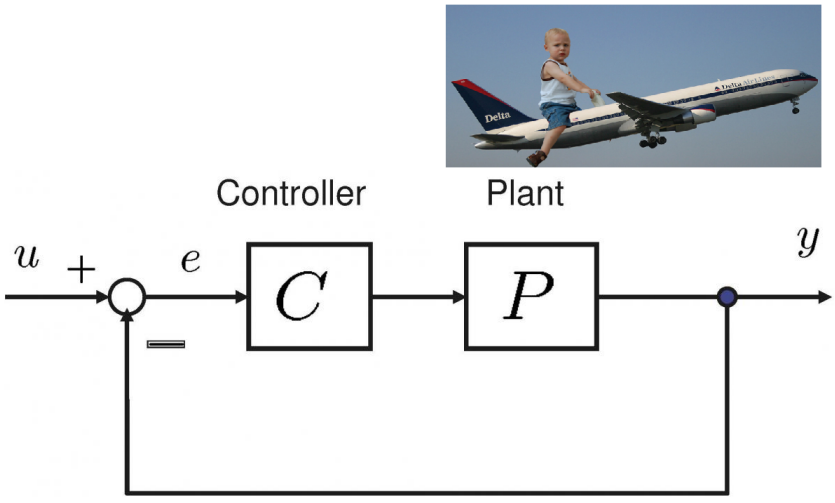

Figure 1: Roll angle control of an airplane.

The objective of this project is to design a controller $C(s)$ for a given plant $P(s)$. For this project, the plant is nothing but an airplane. The objective of the controller is to control the roll angle of the airplane. You can think of it as if the baby is controlling the roll angle via his natural abilities that he learned from the EE 3413 class (ha!).

A block diagram representation of this system can be seen in Figure 1, where

$$P(s) = \frac{10}{(s+10)(s^2+2s+20)},$$

and $C(s)$ is the controller/compensator that we want to design. Of course, this block diagram representation is a mass simplification of an actual airplane, which we need to consider if we want to learn design of simple systems.

The design specifications for the overall closed-loop transfer function are the following:

- Zero steady-state error (or near zero if possible) that corresponds to a unit step input $u(t)$,
- A percent overshoot M_p less than or equal to ten percent,
- Settling time t_s less than or equal to two seconds.

For this project, you should use MATLAB (preferably). If you are confident about your algebra abilities, then feel free to use a pen/paper; however, you are required to submit clear, typed solutions and plots for the output step response (and that, you cannot do using a pen and paper).

Answer/solve the following problems (some hints are given after the list of questions):

1. Given the above design specifications, design a P controller ($C(s) = K$). Are you able to satisfy the design specifications given above? Why? Why not? Plot the out step response and the steady state error as a function of time.
2. Design a PI controller that satisfies the above specifications. Are you able to satisfy the design specifications given above? Why? Why not? Plot the out step response and the steady state error as a function of time.
3. Repeat the second question given that you want to design a PID controller.
4. Which controller from the above three (P,PI,PID) would you eventually use for the given system? Justify your answer.

Hints:

- *Hint 1:* You might approximate the above plant by a second order transfer function as we discussed in class if you find that helpful. You don't have to, of course. You have the full freedom.
- *Hint 2:* You can relax some of the design specifications to achieve other ones. For example, if for the P controller one design spec cannot be satisfied, make sure to at least satisfy one of the other ones.