Information Engineering & Technology
Electronics, Communications, & Networks
Systems & Control Course
Evaluation Project

Systems and Control Project

Directions:

- A simulation using **MATLAB** and **P-Spice** is a must for this project.
- Plot the responses got by MATLAB and P-Spice and the codes used in both.
- Soft copies of the solution and hard copies are required.
- Solution must be in groups of **3- 4 students**, not more.

An e-mail to be sent Eng. samar.shukry@guc.edu.eg that include the name of each member in the group, ID number and the lab group.

GOOD NEWS: cross-labs is allowed ☺

- This project is of **20% of the total score** of the Systems & control course.
- Evaluation dates for the project is on 4/12 and 5/12.
  (the exact timing for each group to be announced later)

Objective:

The objective of this project is as follows:

- A practical application on the Systems and Control course.
- Analyzing some given Processes.
- Designing the PID controller to get a specific response.
- Tuning the PID controller using different rules.
- Designing Lead-Lag Compensator to get a specific response.
- Tuning the Lead-lag compensator.
- Improving either the transient or the steady state responses or both for any system.

Procedure:

Students are required to do the following:

- Analyzing the given transfer function and designing the required electric circuit (Using Op-Amps) and hence draw both its block diagram and its hardware Circuit Components (written analysis).
- Analyzing the system response for a given plant with unity feed back path for both transient and steady state responses.
- Designing an analog circuit that represents a PID controller with the flexibility of changing its parameters.
- Analyzing the system after inserting the controller in the feed forward path for both transient and steady state response (using MATLAB and Simulink)
- Deducing the improvements made by the controller.
- Designing an analog circuit that represents a Lead-Lag compensator with the flexibility of changing its parameters.
- Analyzing the system after inserting this new controller in the feed forward path for both transient and steady state response (using MATLAB and Simulink)
- Deducing the improvements made by the controller.
- Checking hardware validity using P-Spice.
- Designing the Hardware circuit (This part is a **Bonus**).

Steps:

For the forward transfer function shown:

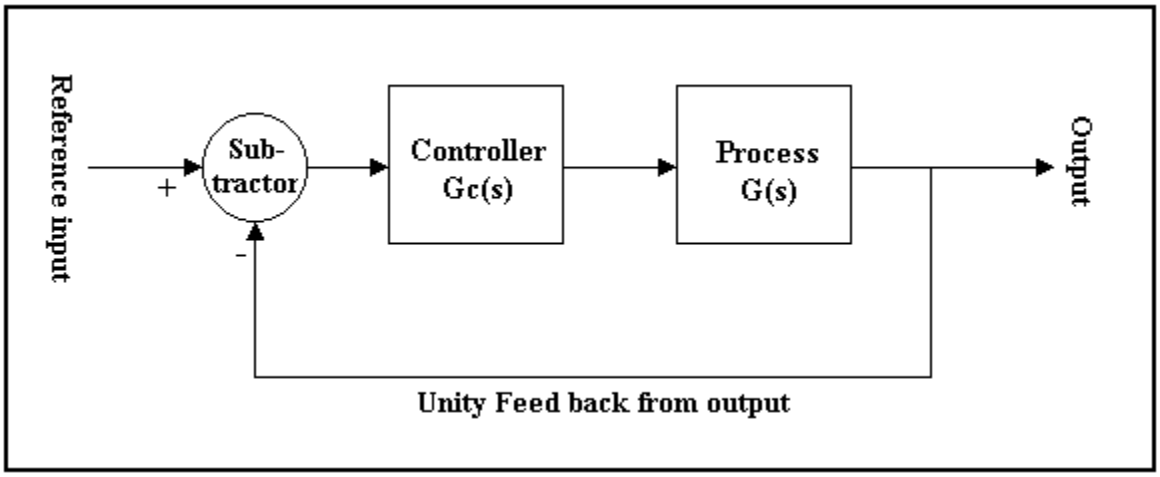
$$G(s) = \frac{{\omega_n}^2}{s^2 + 2\zeta\omega_n s + {\omega_n}^2}$$

Where ω_n is the last 2 numbers in the smallest ID in the group, and ζ is equal (0.5 if ω_n is multiple of 5, 0.25 if ω_n is multiple of 3, else ζ is equal 0.75.

You are required to do the following (assuming Ideal Opamps):

- Design the equivalent electric circuit (using op-amps) describing your open loop transfer function of this process G(s).
- Derive the closed loop transfer function (unity feed back) with the values of components given above assuming unity feedback.
- Use MATLAB to get the Step response, Impulse response, Rise time, Peak time, Settling time, Maximum peak response, Bode plots, and Root loci of this system.
- Use P-spice to simulate the response of the hardware built process.

- Compare your results with the results obtained by MATLAB.
- Now, It's required to design a controller $G_c(s)$ to improve the system response as shown:



- Use MATLAB to design the parameters of that PID controller to get a maximum peak of approximately ***20%*** and steady state error not more than **5%**.
- Build the analog circuit that represents the PID controller with the flexibility to use only P, PI, PD, or PID controller.
- Derive the system closed loop transfer function after inserting the controller.
- Analyze the complete system using MATLAB, Simulink and P-spice and compare the results.
- Build the analog circuit that represents the Lead- Lag Compensator with the flexibility to use only Lead, Lag or both Lead-Lag compensator.
- Derive the system closed loop transfer function after inserting this new controller.
- Analyze the complete system using MATLAB, Simulink and P-spice and compare the results.