System and Control Project Requirements

1. Design values of K & K_f in the servomotor based on your hand analysis using ζ and ω_n of your IDs. ***Hint:*** *J = 1 Kg/m² and a = 1 N.m/rad.sec*
2. $G(s)$ equation (hand analysis) based on the designed Circuit.
3. Code and graphs of inputting different inputs (Impulse and Step) for the $G(s)$ (Matlab, and Simulink).
4. Comment on the graphs regarding the stability of the system. Justify your answer.
5. Total transfer function (T.F) (with negative unity feedback) (hand analysis).
6. Code and graphs of inputting different inputs (Impulse and Step) for the Total T.F (Matlab, and Simulink).
7. Referring to the graphs, discuss whether the feedback affected the stability or not. Clarify your answer.
8. Root Locus (Matlab).Comment whether the gain adjustment can enhance the stability or not.
9. Bode Plot (Matlab). Comment on the Gain and Phase margins.
10. Design PID (equations) (hand analysis). With flexibility to use P, PI, PD or PID.
    Hint: Use the Design problem uploaded on cms
11. Code and graphs of inputting different inputs (Step, Ramp, and Parabolic function) for the system with the chosen controller (Matlab, and Simulink).
    Comment considering the following:
    a. The effect of your controller block on the system type.
    b. The steady state error value for unit step, ramp, and parabola. Compare your results in Matlab and hand analysis.
12. Find the rise time, peak time, maximum overshoot, and settling time (due to different inputs i.e. Step, Ramp, and Parabolic functions) of the system with the controller (Matlab, and Simulink).
13. New values of tuning the controller parameters if needed and **repeat previous steps**.
14. Comment on graphs and tuned values.
15. Root Locus of the system after the controller (Matlab). Did it change? How might the stability be affected?
16. Bode Plot of the system after the controller (Matlab).Comment regarding the stability. Justify your answer.
17. Design Lead-Lag Compensator (equations) (hand analysis) (**instead of the PID**). With flexibility to use Lead, Lag, or the whole Lead-Lag design.
18. Code and graphs of inputting different inputs (Step, Ramp, and Parabolic function) for the system with the chosen compensator (Matlab, and Simulink).
    Comment considering the following:
    a. The effect of your compensator block on the system type.
    b. The steady state error value for unit step, ramp, and parabola. Compare your results in Matlab and hand analysis.

19. Find the rise time, peak time, maximum overshoot, settling time, steady state error (due to different inputs i.e. Step, Ramp, and Parabolic functions) of the system with the compensator (Matlab, and Simulink).
    1. New values of tuning the compensator parameters if needed and repeat previous steps. ***Hint:*** *Tuning can include changing the gain or slightly shifting the positions of the new poles, zeros or both (Note that the Kp should be less than 60 and the Kd should be less than 30)*

20. Comment on graphs and tuned values.
21. Root Locus the system with compensator (Matlab). Did it change? How might the stability be affected?
22. Bode Plot the system with compensator (Matlab). Comment regarding the stability. Justify your answer.
23. Build the hardware design of your total system and verify the results obtained practically. **Use the below link for the required hardware components, detailed steps of design and required Arduino code.**

    https://srituhobby.com/what-is-a-pid-controller-and-how-does-it-work-with-an-arduino