System and Control Project Requirements

1. Analog electric design (using Opamps) of the feed-forward transfer function G(s).
2. G(s) equation (hand analysis) based on the designed electric Circuit.
3. Design values of electric circuit components of G(s) design (hand analysis) based on practical values. **Hint:** Resistors are in KΩ, and Capacitors are in μF.
4. Code and graphs of inputting different inputs (Impulse and Step) for the G(s) (Matlab, and Simulink).
5. Comment on the results.
6. Total transfer function (T.F) (with negative unity feedback) (hand analysis).
7. Code and graphs of inputting different inputs (Impulse and Step) for the Total T.F (Matlab, and Simulink).
8. Comments on the graphs taking into consideration the system type.
9. Calculate the rise time, peak time, maximum overshoot, settling time (due to the step input), steady state error (due to different inputs i.e. Step, Ramp, and Parabolic function) (hand analysis, from Matlab figures, and from Simulink).
10. Compare results of Hand analysis, Matlab, and Simulink.
11. Root Locus (Matlab).
12. Bode Plot (Matlab).
13. Design PID (equations) (hand analysis).

Hint: Referring to the plant function (Feed-Forward TF G(s)), you have to decide whether the Tuning Methods of Ziegler-Nicholas (1st and 2nd methods) are applicable or not based on their conditions. Specifically, for the 2nd method, the difference between the number of poles "n" and that of zeros "m" must exceed 2 i.e. n-m > 2. In case both methods fail, you can follow the example in the uploaded Design Problem on the eee website.

14. Design values of R's and C's of the PID circuit (hand analysis) based on practical values.
15. Code and graphs of inputting different inputs (Step, Ramp, and Parabolic function) for the system with PID (Matlab, and Simulink).
16. Find the rise time, peak time, maximum overshoot, settling time, steady state error (due to different inputs i.e. Step, Ramp, and Parabolic function) of the system with PID (Matlab, and Simulink).
17. Comment on the results of Matlab, and Simulink taking into consideration the system type, and the input.
18. New values of tuning of the PID parameters if needed and repeat steps 14, 15 and 16.
19. Comment on graphs and tuned values.
20. Root Locus the system with PID (Matlab).
21. Bode Plot the system with PID (Matlab).
22. Design Lead-Lag Compensator (equations) (hand analysis) (**instead of the PID**).
23. Design values of R's and C's of the Lead-Lag circuit (hand analysis) based on practical values.
24. Code and graphs of inputting different inputs (Step, Ramp, and Parabolic function) for the system with the compensator (Matlab, and Simulink).
25. Find the rise time, peak time, maximum overshoot, settling time, steady state error (due to different inputs i.e. Step, Ramp, and Parabolic function) of the system with the compensator (Matlab, and Simulink).

26. Comment on the results of Matlab, and Simulink.
27. New values of tuning of the Lead-Lag compensator - if needed - and repeat steps 23, 24 and 25.
28. Comment on graphs and tuned values.
29. Root Locus the system with compensator (Matlab).
30. Bode Plot the system with compensator (Matlab).
31. Implement the Hardware Circuit of your total system and verify the results obtained practically **(Bonus).**

N.B.

Submit the hardcopy of the project (Screen shots of all the Matlab Codes and the resultant graphs, Simulink models and the resultant scopes) and get the softcopy of this project with you during the evaluation on a laptop ready for inspection.