

**Desired characteristics:**

Overshoot: less than 5%

Settling time: less than 0.6s

Steady-state error: less than 1.5%

- 1- Open loop analysis(Step response)
  - Find  $M_p$ ,  $T_p$ ,  $T_r$ ,  $T_s$ ,  $E_{ss}$ .
  - Plot Bode & Nyquist diagrams.
  - Find gain margin & phase margin.
  - Plot root Locus diagrams.
- 2- Design the following controllers based on the desired characteristics.
  - a. **Lead-lag** controller.
    - Time domain with root Locus method.
    - Frequency domain with bode method
  - b. **PID** controller.
  - c. **State feedback** controller.
- 3- Simulate & implement the closed-loop system with all above controllers, separately in the Simulink.
  - Plot the control signal.
  - Compare the closed-loop output and input signals with the different designed controllers.
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- 4- Investigate the effect of variations of the main model parameters without changing the controllers and compare the results. (For example: change the value of a model parameter by 10%)

❖ In all above sections, student's personal conclusion in few paragraphs is necessary.

**Note:**

Please pay attention to the deadline of your homework.

Please put all m files, Simulink files, plots and project report (pdf) in a zip file.

Please send your homework to "9631075" in the sess system.