A framework for control design and analysis

1. Obtain a system model $G(s)$ via
   a. system modeling from 1st principles
   b. system identification procedure (ala Labs 15 / 16)

2. Understand control objectives
   a. Types of reference inputs
   b. Disturbance or noise characteristics
   c. Interpret from customer’s requirement and components’ specifications

3. Choose a controller structure $C(s)$
   a. Proportional P (lab 17)
   b. Proportional-Integral PI (lab 18)
   c. (Proportional-Integral-Derivative PID)
   d. with or without Feedforward (lab 19)
   e. Internal model (lab 20)

4. Derive closed transfer functions with controller
   a. Different transfer function for different inputs (reference, disturbance, noise etc.)

5. Analyze controller performance
   a. Analyze stability
      i. Conditions when all poles have negative real parts
   b. Analyze performance for different pole locations
      i. Steady error with respect to reference input, disturbance, etc.
      ii. Transient response: speed of convergence, oscillations etc.
      iii. Frequency response: what input/disturbance spectra does it do a good/bad job

6. Based on analysis in step 5, choose desirable pole locations

7. Design controller parameters in $C(s)$, i.e. the control gains, that generate the desired closed loop poles

8. Simulate the response to reference and disturbance

9. Design feedforward controller for the closed loop system (if necessary) and simulate response

10. Analyze robustness
    a. Can the system remain stable when the initial guess of the system model $G(s)$ is off?
    b. How sensitive is the performance affected by deviation of the system model $G(s)$?

11. Implement control

12. Go back to step 6 or to step 3 to choose another controller if performance is not adequate