BE 440/ChE 441
Unified Systems Bioengineering II/ Process Control
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Learning Objectives for BE 440/ChE 441

After completing the first week you should:

a) Have a working knowledge of the terminology of control systems
b) Explain why a first order response would be typical for a real system
c) Be able to analyze the data from a system to determine the parameters in a FOPDT model
d) From process response data obtain parameters for higher order models (e.g., SOPDT)

After completing the second week you should be able to:

a) Know how to use Control Station®
b) Explain the actions of a proportional only controller
c) Explain the effect of the controller gain on the response
d) Explain why an offset exists for a proportional only controller
e) Explain the actions of a proportional-integral controller.
f) Explain why integral action eliminates offset.
g) Explain wind-up, its causes, and its effect on controller performance.

After completing the third week you should be able to:

a) Develop dynamic models of processes from basic balances (material, energy, etc.)
b) Linearize any non-linear dynamic equations
c) Express the dynamic equations for a process in terms of deviation variables

After completing the fourth week you should be able to:

a) Solve the resulting dynamic equations numerically using either MathCAD or Matlab (Simulink)
b) Use LaPlace transforms to obtain solutions to linear ODE's
c) Be able to determine the response of a first order system to a variety of inputs

After completing the fifth week you should be able to:

a) Know the form of the response of a second order system based upon the three parameters describing a second order model
b) Be able to determine the response of a second order system to a variety of inputs
c) Be able to incorporate deadtime into the dynamics of a system

After completing the sixth week you should be able to:

a) Convert written descriptions of control systems to a block diagram
b) From a block diagram of a system derive the overall transfer function from the individual unit transfer functions
c) From the overall transfer function of a process be able to determine basic system properties, such as stability, oscillatory behavior, settling time, initial and final values
d) Derive transfer functions for interacting systems
e) Know what instrumentation is needed to determine typical process variables (temperature, pressure, flow rate, composition)

After completing the seventh week you should be able to:

a) Be able to properly size a control valve
b) Be able to incorporate the pressure drop in the piping system with that of the valve to determine overall behavior

After completing the eighth week you should be able to:

a) Convert controller tuning parameters to adjustments typically found on a controller
b) Determine the appropriate tuning parameters from response curves using suggested tuning rules
c) Determine the appropriate tuning parameters based on integrated error criteria
d) Determine the appropriate tuning parameters based upon stability criteria (ultimate gain)
e) Be able to construct and interpret a root locus plot

After completing the ninth week you should be able to:

a) Use Matlab to construct a root locus plot and specify various performance criteria (decay ratio, overshoot, etc.)
b) Construct and use a Bode plot to determine a system's performance from its frequency response
c) Use the tools in Matlab to construct a Bode plot.
d) Use direct synthesis to compute controller parameters to meet performance criteria you select.
e) Know the limitations of direct synthesis for certain types of process models, such as deadtime

After completing the tenth week you should be able to:

a) Know how internal model control systems are designed to operate
b) Compute the parameters for a PID controller that would give equivalent performance to an IMC system.
c) Be able to implement IMC control in systems with noninvertible actions

After completing the eleventh week you should be able to:

a) Describe how model based control systems, such as Dynamic Matrix Control, differ from typical feedback systems (PID control)
b) Implement and tune a cascade control system
c) Know the conditions under which cascade control is advantageous.
d) Know the limits of cascade control.

After completing the thirteenth week you should be able to:

a) Implement and tune a feed forward control system
b) Know the conditions under which feed forward control is advantageous.
c) Know the limits of feed forward control.