WEEK 10 PROPORTIONAL CONTROL THEORY & MODELLING

Week 10 Report

Submission of final report and oral presentations (10 minute limits).

WEEK 10 ORAL PRESENTATION CONTENTS

Background
Brief description of system, "input" and "output"
Brief description of performance curves (SSOC)
Objective of controller design
Theory
Brief review of system transfer function (FOPDT or other) (include parameter values)
Description of feedback control in your system
CLTF for your system
Root locus
Modelling
Model & parameters
Results
Sample time-response graphs
Offset as function of K_c
K_{cu}, K_c for quarter decay, K_c for critical damping, range of K_c for underdamped, range of K_c for overdamped
Conclusions
"For a______________ response with an offset of _________,
our system needs a proportional controller with a K_c of ____."

Some suggested slides for Week 10 Report

Background
Theory
Modelling
Results
Conclusions

Theory
Transfer function
Parameters
Feedback control
CLTF

Results
Time response
Offset
K_c results (table)

Background
System
Input
Output
SSOC
Operating Range
Root locus
Controller objectives

Modelling
Model equations
Parameters
Feedback control

Conclusions

Objectives

To observe the operation and behavior of your system's approximate linear FOPDT model with proportional control. To observe the effect of the value of the proportional feedback gain, K_c. To observe the limits of stable operation of the closed loop system. To observe the response of a closed loop controlled system to a set point change. To find K_c for critically damped response, quarter decay response and K_{cu}.

Reference: Smith & Corripio, pp 159-163, 225-226

Smith & Corripio (p. 209) has a formula for finding K_{cu} if you know the FOPDT parameters.

Disk File Suggestion: For all your data files that you save this week, start their names with "W10" (meaning week #10)

Note about "Marginally Stable Behavior"

For linear systems (the subject of ENGR 328), if $K_c > K_{cu}$, the output will be increasingly oscillatory without any bounds. For real systems (like in ENGR 329), the output can never grow without bounds because eventually the system will go outside of its operating range and reach a physical limit. Examples of limits are (1) an Accuspede power supply can only put out voltages within some finite range and (2) water level in a tank can not be negative.

So, the K_c for "marginally stable behavior" in the real world means that at smaller values of K_c, the oscillations are damped and for larger values of K_c, the oscillations are not damped. That is, the oscillations are sustained indefinitely.

WEEK 11 PROPORTIONAL CONTROL EXPERIMENT

PROPORTIONAL CONTROL EXPERIMENTS

Objectives

To observe the operation and behavior of your proportional control system design. To observe the effect of the value of the proportional feedback gain, K_c. To determine the ultimate gain and ultimate period for the closed-loop system. To observe the response to a closed loop controlled system to a set point change and a disturbance input (as appropriate). To tune the controller with approximate modelling results for critically damped response, quarter decay and at the limit of stability.

Reference: Smith & Corripio, pp 211-213

PROCEDURE FOR RUNNING THE PROPORTIONAL-ONLY CONTROLLER

Prepare system for operation

Open LabVIEW program labeled "(P-only)". This program emulates an automatic feedback controller. You should get a panel somewhat like the one shown in Figure 19. On this panel, you put the "set point" with the control slide on the left. The "set point" is the value you want for the output variable. Set the value you want for K_c, the proportional controller gain, with the knob or in the appropriate window. Click on the RUN arrow.

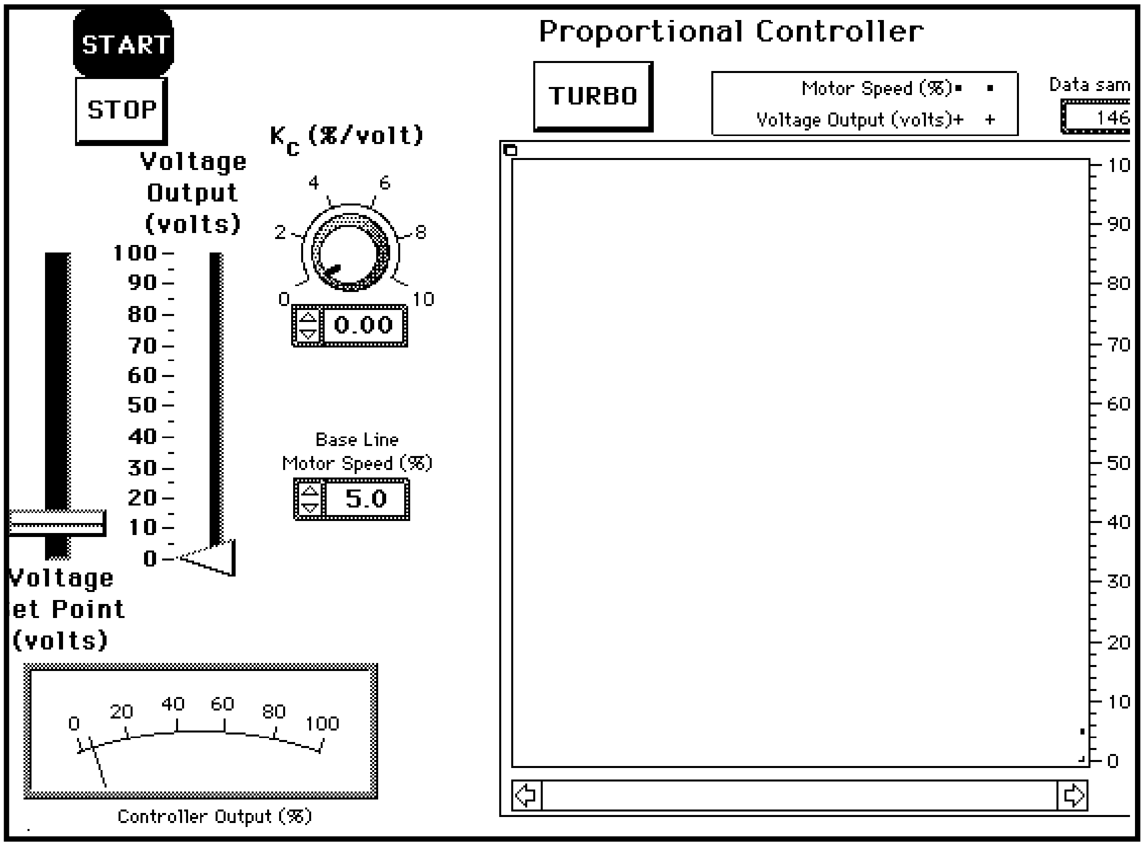

Figure 19. Proportional-only automatic controller panel

Choose the value of K_c that your theory and approximate modelling predict will be good for you system. You can observe the system's response to a step change in set point by changing the set point. You can observe the system's response to a disturbance by changing the disturbance input.

The meter in the lower left is the controller output. It is the signal (the "manipulated" variable) sent by the controller to the system.

Experimentally determine what value of K_c gives marginally stable operation (K_{cu}) and determine that frequency (ω_u or f_u, and T_u --see Smith & Corripio, p. 211).

Using the values of K_c that your approximate modelling results gave for various system responses, observe the experimental system responses for the equivalent experiments.

Be sure to remember the note about marginally stable behavior on page 48, above.

Disk File Suggestion: For all your data files that you save this week, start their names with "W11" (meaning week #11)

Week 12 Report

A draft of Week 12 Report is due the second school day before the next scheduled lab meeting.

WEEK 12 REPORT CONTENTS
PROPORTIONAL CONTROLLER PERFORMANCE

Introduction

Theory & Background
Description & explanation of system components & connections
Schematic diagram
Input function and output function
Theory & governing equations for components, system and PI feedback controller
Time domain and Laplace domain descriptions, OLTF, CLTF, characteristic equations, K_{cu}, ω_u
Quarter decay tuning parameters from theory
Block diagram. Root locus plots
Previous system results (gain, time constant, etc.)

Modelling
Equations & methods used in modelling

Results
Performance of system with proportional-only control. (Week 11 experiments)
Estimates of errors in results.

Discussion
Comparison of theory, modelling and behavior of experimental system responses with proportional only control

Conclusions
Values of K_c, τ_I, for specified system response

Recommendation

Appendices
Physical properties
Modelling diagram, equations
Data curves & calculations

Attachments
Include a sheet for each team member that describes the contribution to the work in the laboratory since last reported.
