ECE 100: Introduction to Engineering Design

Engineering Library Resources Project No. 1 (Continued)

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Seating Arrangement

Team 1 / Team 3	Team 4 / Team 5
Team 2 / Team 3	Team 4 / Team 6
Team 7	Team 8 / Team 9
Team 11	Team 8 / Team 10

Some Course Business Items…

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- A revised version of the Project No. 1 description has been posted on the course website - specifically, it features updated tables for the IMC and ACME policies.

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- Be careful regarding what you can and cannot do with the Graphical Spreadsheet that has been made available for the Project.

  - Generate multiple versions of the Excel file, as opposed to creating/eliminating worksheets

Occam's Razor

"…Non sunt multiplicanda entia praeter necessitatem."

William of Occam
14th Century Philosopher

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Translation:
Things should not be multiplied without good reason.

Occam's Razor (Continued)

- A modeling *heuristic (*involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods <heuristic techniques> <a heuristic assumption>)

- In modeling, eliminate all unnecessary information relating to the problem that is being analyzed.

Model-Based Controller Tuning

- A model-based tuning rule simplifies the choice of controller tuning parameters.

- We will consider a tuning rule for an "integrating" system which relies on the concept of Internal Model Control (IMC).

- User supplies the order fulfillment time (θ) and only one adjustable parameter (λ), which is inversely proportional to the closed-loop speed of response

  – Increasing λ makes the system sluggish; decreasing λ speeds it up.

  – Be careful about going too fast - it may introduce instability and/or bullwhip…

Controller/Decision Policy Example

(From Penn State Presentation)

$$O(k) = O(k-1) + K_1 e(k) + K_2 e(k-1) + K_3 e(k-2) + K_4 \Delta O(k-1)$$

Current Decision (“Dosage”) = Previous Decision (“Dosage”)
+ Scaled Corrections from Current and Prior Control Errors
+ Scaled Controller “Move”

K_1, K_2, K_3, and K_4 are *tuning constants* in the controller / decision policy

The character and tuning of the decision policy can be adjusted using *tailoring* variables

IMC, Inc. Tuning Rules (Revised)

$$u(t) = K_c e(t) + \frac{K_c}{\tau_I}\int_0^t e(t')dt' + K_c \tau_D \frac{de}{dt} - \tau_F \frac{du}{dt}$$

Model		K_c	τ_I	τ_D	τ_F
BRONZE	$\beta = \theta/2$	$\frac{2\lambda+\beta}{(\lambda+\beta)^2}$	$2\lambda + \beta$	-	-
SILVER (Level I)	$\tau = \theta/2$	$\frac{2\lambda+\tau}{\lambda^2}$	$2\lambda + \tau$	$\frac{2\lambda\tau}{2\lambda+\tau}$	-
SILVER (Level II)	$\beta = \theta/2$ $\tau = \theta/2$	$\frac{\beta+2\lambda+\tau}{(\beta+\lambda)^2}$	$\beta + 2\lambda + \tau$	$\frac{\tau(\beta+2\lambda)}{\beta+2\lambda+\tau}$	-
GOLD	$\beta = \theta/2$	$\frac{2(\beta+\lambda)}{2\beta^2+4\beta\lambda+\lambda^2}$	$2(\beta + \lambda)$	-	$\frac{\beta\lambda^2}{2\beta^2+4\beta\lambda+\lambda^2}$
PLATINUM (Level Two)	$\beta = \theta/2$	$\frac{2(\beta+\lambda)}{2\beta^2+\lambda^2}$	$2(\beta + \lambda)$	$\frac{2\beta\lambda}{\beta+\lambda}$	$\frac{\beta\lambda^2+4\beta^2\lambda}{2\beta^2+\lambda^2}$

Table 1: IMC, Inc. PID Controller Tuning Rules. θ represents the order fulfillment time. The IMC Platinum Level I policy corresponds to the one evaluated in Modeling Assignment No. 3.

ACME, Inc. Tuning Rules (Revised)

$$u(t) = K_c e(t) + \frac{K_c}{\tau_I}\int_0^t e(t')dt' + K_c \tau_D \frac{de}{dt}$$

Model	K_c	τ_I	τ_D	τ_F
BRONZE	0.2	20	-	-
SILVER (Level I)	$0.9/\theta$	3.3θ	-	-
SILVER (Level II)	$0.67/\theta$	6.0θ	-	-
GOLD	$(10+\theta)/100$	$10+\theta$	$10\theta/(10+\theta)$	-
PLATINUM	$1.2/\theta$	3.3θ	0.5θ	-

Table 2: ACME® PID Controller Tuning Rules

Project No. 1 Point Breakdown

- Total Number of Points: 245:
  - 50 pts for Modeling Assignment No. 4; i.e. spreadsheets associated with
    - IMC, Inc. and ACME-brand decision policy implementations
    - Enhanced policies using demand forecasts (and demonstration of their effectiveness)
  - 125 pts for Project Report and Group Summary
  - 50 pts for Project Presentation
  - 20 pts for Team Process Check

Upcoming Class Sessions

- Thursday, March 27.
  - Presentation on Presentations; class will dismiss no later than 12 noon.
- Thursday, April 3.
  - Project No. 1 Reports are due
- Tuesday, April 8.
  - Team Project Presentations.