Process Control, 3P4

Assignment 7

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This assignment gives you practice with multiloop control.

Question 1 [5]

From a previous final exam

A 2x2 subsystem, derived from step inputs to a heavy oil fractionator, lead to the following transfer function model:

$$y_1 = \frac{1.2e^{-27s}}{45s+1}m_1 + \frac{4.5e^{-27s}}{50s+1}m_2$$
$$y_2 = \frac{1.4e^{-8s}}{19s+1}m_1 + \frac{4.0}{13s+1}m_2$$

where

- y_1 = top end point
- y_2 = intermediate reflux temperature
- m_1 = top draw rate
- m_2 = intermediate reflux duty

Use a relative gain array analysis to calculate the appropriate loop pairing for this system.

Question 2 [27 = 5 + 6 + 8 + 8]

From a previous final exam

Step tests on a distillation column with a methanol-water feed resulted in the following transfer function model:

$$y_1 = \frac{10e^{-7s}}{15s+1}u_1(s) - \frac{17e^{-2s}}{21s+1}u_2(s) + \frac{4e^{-8s}}{15s+1}d(s)$$
$$y_2 = \frac{6e^{-7s}}{10s+1}u_1(s) - \frac{17e^{-3s}}{12s+1}u_2(s) + \frac{5e^{-3s}}{13s+1}d(s)$$

where:

- y_1 = overhead methanol mole fraction
- y_2 = bottoms methanol mole fraction
- u_1 = reflux flow rate
- u_2 = reboiler steam flow rate
- d = feed flow rate

1. Draw a diagram of the equipment, showing the sensor and manipulated variable locations.
2. Determine the appropriate loop pairing for this system.
3. Draw a complete block diagram of the controlled system showing clearly all the transfer function elements.

4. Since the feed flow rate can be readily measured, design a feedforward control system for this process, and show on your block diagram how it would be implemented along with the feedback control system. You may express your design in terms of the transfer function element identifiers $g_{11}(s)$, $g_d(s)$ *etc*. without substituting the analytical expressions for the transfer functions.

END