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MECM - 203

M.E./M.Tech., II Semester

Examination, June 2016

Advanced Process Dynamics And Control

Time : Three Hours

Maximum Marks : 70

Note : Attempt any five questions. All questions Carry equal marks, draw neat sketch and assume suitable data wherever you required.

1. a) Derive the ramp response of :
   i) Underdamped,
   ii) Critically damped and
   iii) Overdamped second-order systems. What is the steady-state component of these responses?

   b) Explain procedure of determining tuning constant for good control performance.

2. a) A second-order system is underdamped with a damping ratio of 0.4 and a natural frequency of 10Hz. Find :
   i) the transfer function
   ii) the time response when it is subjected to a unit-step input
   iii) the percentage overshoot with such an input
   iv) the rise time

   b) With the help of mathematical equations, explain how the stability of a process is determined numerically.

3. a) Explain the following methods of controllers tuning :

   i) Open loop transient response method.

   ii) Ziegler Nichols method

   b) Draw the complete Nyquist plot for a unity feedback system having the open loop function

$$G(s) = \frac{6}{s(1+0.5s)(6+s)}$$ from this plot obtain all the information regarding absolute as well as relative stability.

4. a) What is an optimal tuning control? What are its different approaches? http://www.rgpvonline.com

   b) The forward path transfer function of a Unity-feedback control system is given as $G(s) = \frac{6}{s(1+0.1s)(1+0.5s)}$.

   Draw the Bode plot of G (s) and find the value of K so that the gain margin of the system is 20 dB.

5. a) Explain the use of cascade and feed-forward control strategy for distillation column feed control.

   b) Explain Split range control strategy with suitable example.

6. a) Explain in detail the general purpose adaptive regulator.

   b) Furnaces are often used to heat process streams to temperatures above 400°F. A typical fired furnace may have a heat duty of 100x106 Btu/hour, requiring roughly 1667 scfm (standard cubic feet per minute) of natural gas (methane has a fuel value of approximately 1000 Btu/scf).

The cost of this fuel gas is on the order of \$5/1000 scf, yielding an annual fuel cost of \$4.4 million/year. Excess combustion air is needed to assure complete combustion; however, too much excess air wastes energy (the heated air simply goes out the exhaust stack). Too little excess air leads to incomplete combustion, wasting energy and polluting the atmosphere with unburned hydrocarbons. It is important, then, to deliver an optimum amount of combustion air to the furnace. With the large flow rates and high temperatures involved, maintaining safe operation is also very important. The control system must be designed so that excess combustion air is maintained, no matter what is happening to the fuel gas flow rate. A fired furnace control system clearly needs to satisfy safety, environmental, and economic criteria.

7 a) What is an interactive? Explain its effect on stability and tuning of Multi loop control system.

b) The multivariable process is given by following transfer function. http://www.rgpvonline.com

$$Gwb(s) = \begin{bmatrix} \frac{12.8e^{-s}}{16.7s+1} & \frac{-18.9e^{-3s}}{21s+1} \\ \frac{6.6e^{-7s}}{10.9s+1} & \frac{19.4e^{-3s}}{14.4s+1} \end{bmatrix}$$

i) Design suitable static decouples,

ii) Develop multivariable control system.

8. a) List some of the advantages and disadvantages of sampled data control system?

b) Discuss the effect of digital control on stability, tuning and performance of control systems.

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