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Roll No ....

CM-6003-CBGS

B.E. VI Semester

Examination, June 2020

Choice Based Grading System (CBGS)

Chemical Process Control

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions.
ii) All questions carry equal marks.
iii) Assume suitable data wherever necessary.

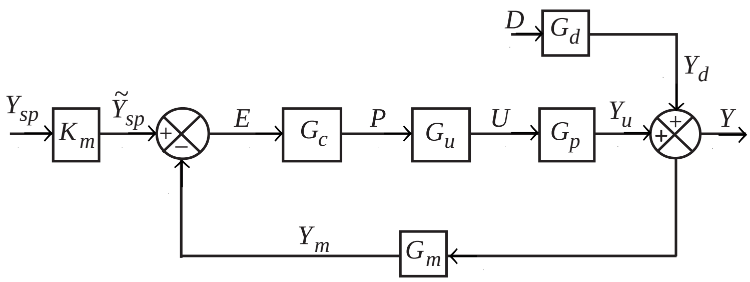
1. a) Explain with the suitable example how the design of a feedback controller involves the compromise between the robustness and the accuracy
   b) Write the working principle of a reverse acting controller and give any appropriate example.
   c) Write the merits and demerits of ZN tuning method.

2. a) What is the significance of the time constant? Explain why the time constant for a first order process is 63.2% of the ultimate response.
   b) Can Root Locus diagram (method) be used for stability analysis of the process having time delay. In either case, explain how and why?

3. Distillate composition in a distillation column in controlled using PI controller by manipulating the reflux rate.
   a) Is this a direct acting or reverse acting control mechanism (assume that transmitter is direct acting and valve is air to open)? Explain your answer.
   b) Discuss the effect of varying controller gain and integral time on the composition control.

4. A PD controller having the derivative time (τ_D) equal to 0.5 is used to control two non-interacting first order systems having time constants of 1 and 2. The gain of the system is 2. Draw an appropriate block diagram for this process and determine the stability of the control system using Routh criteria.
(Note: assume $G_v = 1/s$ and $G_m = 1$).

5. a) Derive the closed loop transfer function `Y/D` (i.e. process output to disturbance variable) for the following process.



b) State and justify whether or not the following equation will exhibit oscillatory response.

$$\frac{d^3y}{dt^3} + 2\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + y = 3$$

6. For the process having a transfer function

$$G(s) = \frac{Y(s)}{U(s)} = \frac{2(s+0.5)e^{-5s}}{(s+2)(2s+1)}$$

a) Put above the transfer function in a standard form (without numerator dynamics).
b) Determine gain, poles and zeros.
c) Suitably apply the approximation for a time delay term and repeat part (b).

7. Dynamics of a chemical process is exhibited by the following transfer function:

$$G(s) = \frac{Y(s)}{U(s)} = \frac{30}{60s + 6}$$

a) What is the steady state gain time constant?

b) For a step change of magnitude 2, what is the value of the y(t) when time tends to infinity.

c) For an unit impulse change at t = 0, what is the output when time tends to infinity.

8. a) Explain what is a soft sensor? How it can be developed for any process if (1) input output data are experimentally known but the process is poorly understood and (2) input output data are not known, rather the process is understood well.

b) A thermometer having a time constant of 0.1. min is at a steady state temperature of 90 F. At time \`t\`= 0, the thermometer is placed in a bath maintained at 100 F. Determine the time need for the thermometer to show a reading of 98 F. Assume that the thermometer shows a first order dynamics.

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