M.Tech. First Semester (Chemical Engineering) (CBS)
13003 : Process Control : 1 CE 3

P. Pages : 2

Time : Three Hours

AU - 3276

Max. Marks : 80

Notes :
1. All question carry marks as indicated.
2. Answer **any six** question.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Diagrams and chemicals equations should be given wherever necessary.
6. Illustrate your answer necessary with the help of neat sketches.
7. Discuss the reaction, mechanism wherever necessary.
8. Use of cellphone is not allowed in exam.
9. Use of pen Blue/Black ink/refill only for writing the answer book.

1. a) Explain what is meant by Multiplicity of steady states with the help of a suitable example. **6**

   b) The tank shown below has a cross sectional area of $100 cm^2$. At a steady state input flowrate of $18 cm^3/sec$, the steady state level of water in the tank is 36cm. If the output flow rate Q_0 is related to the level H by the equation $Q_0 = 3\sqrt{H}$, obtain the transfer function based on linearized equation. **7**
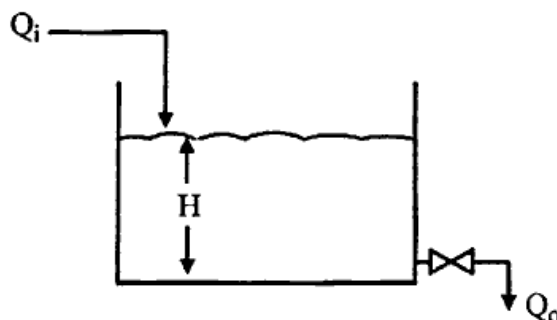
2. a) Calculate analytically the ultimate gain for the transfer function. **7**

   $$G(s) = \frac{k}{(s+1)^3}$$

   b) The cross over frequency of the transfer function. **7**

   $$G(s) = \frac{2e^{-s}}{(\tau s+1)^2}$$

   is found to be 0.6 rad/min. Calculate the time constant T.

3. Draw the root locus diagram for the open loop transfer function **13**

   $$\frac{ke^{-s}}{(s+1)}$$

4. a) Discuss the concept of split range control with suitable examples with their advantages and disadvantages. **7**

   b) Describe the inverse response with its concept with the help of suitable example. **6**

---

5. The reaction $A \rightarrow B$ ($k = 0.02\,min^{-1}$) takes place in a CSTR. The reactor hold up is 2000 liters while the feed rate is 100 lit/min. The inlet concentration of A varies sinusoidally with a mean value of 0.01 mol/lit and a frequency of 1 rad/min. If the amplitude of the input is 0.001 mol/lit. Obtain an expression for the outlet concentration as a function of time. **13**

6. What is meant by compensation for a transportation lag? A control loop has a proportional controller with four first order elements in series. The elements have equal time constants equal to unity. The steady state gain for the elements is unity. The transfer function for the loop can be written as $\dfrac{e^{-1.5s}}{3s+1}$ **13**

Draw the block diagram with compensator included.

7. Discuss in detail the control strategies of the distillation column with the qualitative methodology involving the determination of suitable column pressure of distribution concentration for a chemical process plant.   http://www.sgbauonline.com **13**

8. Generate the Bode plot for the following transfer functions. **13**

 i) $\dfrac{k}{(s+1)^4}$

 ii) $\dfrac{k}{s(s+1)^2}$

9. a) Obtain the Z-transforms for **7**
    i) Impulse function
    ii) Ramp function
    iii) Exponential function.

   b) Invert by long division. **6**

   $\dfrac{0.2z}{z^2+z+0.4}$

10. The frequency response analysis of a system shows an asymptotic amplitude ratio with the following characteristics. **14**
    a) A constant value of 10 at low frequencies.
    b) Slope of -1 between frequencies of 0.2 and 2 rad/sec.
    c) Slope of zero between frequencies of 2 and 80 rad/sec.
    d) Slope of -1 at higher frequencies.
    The overall phase angle approaches zero degrees at low frequencies and -90° at high frequencies. Determine the transfer function.

****