AQ – 2748

First Semester M. Tech. (Chem. Engg.) Examination

PROCESS CONTROL

Paper - 1 CE 3

P. Pages : 4

Time : Three Hours] [Max. Marks : 80

Note : (1) Question no. **one** is compulsory.

(2) Assume suitable data wherever necessary.

(3) Illustrate your answer wherever necessary with the help of neat sketches.

(4) Answer any **five** questions from remaining nine questions.

(5) Use pen of Blue/Black ink/refill only for writing the answer book.

1. (a) Describe the working of PNEUMATIC control valve's principles with neat sketch. 7

(b) Describe the step response in Critically Damped second order system in general is;

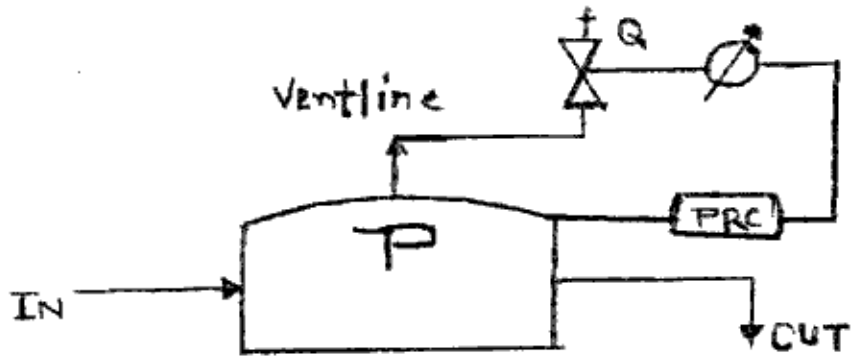
$$G(s) = \frac{Y(s)}{X(s)} = \frac{k}{\tau^2 s^2 + 2\phi\tau s + 1}$$ 8

2. (a) Explain with a suitable example how modified Routh's test is used to determine the stability in a sampled data system. 6

(b) Describe SCADA-supervisory control and Data Acquisition's design and controller for the typical programme for the chemical Industry. 7

3. Discuss the control strategies of the distillation column with the Qualitative Methodology involving the determination of suitable column pressure distribution concentration for a chemical process plant. 13

4. The pressure recorder controller (PRC) having the pressure P in the Vessel as shown :

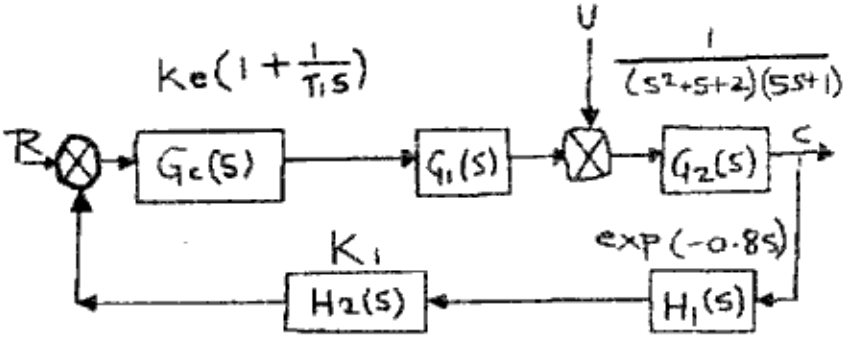


Is controlled by a digital (discrete time) proportional controller of gain Kc. The measurement from the pressure sensor is sampled every 60 secs. for the transmission Via a ZoH element to controller which is connected directly to a control valve on a line which vents the vessel. The transfer function representing the process i. e. between P and the flow rate Q through the vent

approximates to $\frac{P}{Q} = \frac{2}{(1+2s)}$.

It is known that the steady state gains of the control valve and measuring element are 2 units and 0.5 units respectively, and their dynamics are negligible in comparison with that of the process. Find the maximum value of Kc for which the system will remain stable and compare this with the stability of the equivalent entirely continuous (analog) control loop. 13

5. A control system using PI control is represented by the block diagram as



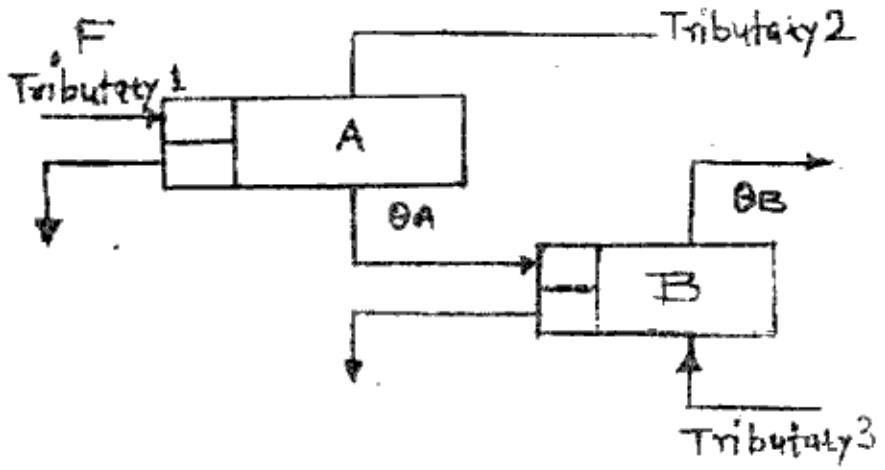
The transfer function describing the various blocks with Kc = 10, T_1 = 60 sec K_1 = 0.8 and K = 0.5. By determination of the gain and phase margins, show the effect on the stability of the control system of introducing the derivates along with T_θ = 60 sec. 13

6. (a) Explain with the neat sketch of the RATIO CONTROL using a suitable example. 6

(b) Obtain the BODE plot for the open loop transfer function

$$G(s) = \frac{Ke^{-s}}{(s+1)\ (2s+1)}$$ 7

7. In the HEAT Exchanger arrangement as illustrated in figure are known:



The response of the temperature Q_A of Tributary 2 leaving exchange A to a change in the rate of flow for Tributary 1 entering is first - order with a time-constant of 10 sec and steady state gain of 20. The response θ_B to a change in θ_A is underdamped second order with a time constant of 180 sec. and damping coefficient of 0.48. The steady state gain is unity. Determine (i) the response of θ_B to a step change of unit magnitude in F and (ii) the frequency response relationships between θ_B and F. Assume the temperatures of all the inlet tributarys and the rate of flow of tributary 2 through A and that of tributary 3 through B to remain constant. 13

8. (a) Draw the ROOT LOCUS diagram for the

$$G(s) = \frac{-K}{s(s^2 + 3s + 9)}$$

Sampled data system with the transfer function for H(s) = 1 and H(s) = s+1 Determine the highest value of K for which the system is stable. 7

(b) Obtain Z-transforms for the common functions such as (i) transportation log (dead time) (ii) Sinusoidal function and (iii) Impulse function. 6

9. Discuss the required process controller's HARDWARE and SOFTWARE for the optimizing Distributed Computer Control Systems (DDCS) for the supervisory level and also the Digital Direct Control (DDC) and Real Time Computer Control (RTCC) with neat sketches and their applications in the chemical Industries. 13

10. Described the scheduled (Programmed) Adaptive control system with their advantages; disadvantages and difficulties in controller design and implementations with respect to —

    (i) Self-Tunning Regulator (STR) and

    (ii) Model Reference Adaptive Control (MRAC)

    their recent developments and future challenges in the field of chemical Industries. 13