Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (AEIE)/SEM-2/EIEM-201 (D-12)/2010
2010
PROCESS CONTROL SYSTEM DESIGN

Time Allotted : 3 Hours   Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* questions.   5 × 14 = 70

1. a) "A higher order process can be approximated by a system having one or two time constants and a dead time." Justify the statement giving diagram and response curves.   4

    b) The process transfer function of a third order system is given by :

$$G(s) = \frac{1}{(s+1)(0\cdot5s+1)(2s+1)}$$

where time constants are expressed in minutes. The true response of the controlled variable *c*(*t*) [output] to a step change in input is shown in Fig-1 on page 2. Approximate the process by a second order dead time model. Obtain the expression for the slope at the point of inflexion of the response curve in the figure and use the following values of λ and η :

λ = 0·368 and η = 0·9   10

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Fig. 1

Comparison of True response with Approximate Response of an Over-damped Second Order System.

2. a) State the steps involved in converting a closed loop analogue control system into a closed loop sampled data control system. 4

   b) Derive an expression for the closed loop transfer function of the above sampled data control system. 10

3. a) What is a Data-Hold device and how is the order of such a device determined ? Justify your statement analytically. 4

   b) Obtain the transfer function of a zero-order hold device. Show the input/output relationship of the zero-order hold appending sketches. 8 + 2
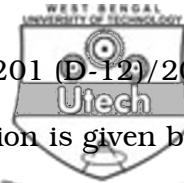
4. a) Consider a process whose transfer function is given by

$G_p(s) = \dfrac{1}{(0 \cdot 4s + 1)}$. The closed loop response requires to have finite settling time, minimum rise time and zero steady state error. Design a suitable digital control algorithm that will satisfy the above requirements, following a step change in input. Assume Sampling period $T = 1$. 11

b) State your observations on the characteristics of the algorithm you have designed. 3

5. a) State the characteristics of a multi-level control system. Why is coordination problem encountered in multilevel control ? 4

b) Show giving reasons and using block diagram, how steady state coordination problem for the complete system can be formulated. 10

6. a) What are

i) a diagraph

ii) a transition matrix

iii) an inter-connection matrix ? 4

b)

Develop the transition matrix and interconnection matrix for the above diagram. 10

7. a) Describe the features of the Batch-controller of the Honeywell TDC 3000 distributed control system. 3

b) Outline the control problem of a thermoset resin plant (Fig. 2) and show how by using the above special purpose batch-controller, the control problem is efficiently tackled. 11

Fig. 2

8. a) Write the merits of fuzzy logic. 4
   b) Evaluate the equation for discrete PI controller. 3
   c) Explain the design principle of a two-input fuzzy PI controller with a proper diagram. 7
9. Write short notes on any *two* of the following : 2 × 7
   a) Sampling frequency in sampled data control system.
   b) Dirac (or Delta) function and the sampler.
   c) Transport delay and its transfer function.
   d) TDC 3000 distributed control system (name the elements only).