Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / B.TECH (ECE-NEW) / SEM-8 / EC-803E/ 2011

2011

MODERN CONTROL SYSTEM

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.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

    i) The faithful reconstruction of a signal (W_1) is obtained after sampling with frequency W_s if

      a) $W_s = W_1$ b) $W_s \geq 2W_1$

      c) $W_s \leq W_1$ d) $W_s \leq 2W_1$.

    ii) Stability of discrete linear systems can be investigated by using

      a) Routh-Hurwitz criterion

      b) bilinear transformation only

      c) both bilinear transformation & R-H criterion simultaneously

      d) only Jury's stability test.

8217   [Turn over

iii) Z-transform of te^{-at} is

a) $\dfrac{T\,e^{-aT}}{\left(Z-e^{-aT}\right)^{2}}$

b) $\dfrac{Z\,e^{-aT}}{\left(Z-e^{-aT}\right)^{2}}$

c) $\dfrac{T\,Z\,e^{-aT}}{\left(z-e^{-aT}\right)^{2}}$

d) $\dfrac{T\,Ze^{-aT}}{z-e^{-aT}}$.

iv) The choice of performance index depends on

a) minimization of time

b) regulation of state or output

c) minimization of cost

d) objective to be realized by control system.

v) The Pontryagin's approach to the optimal control problem results in

a) a closed loop controller

b) an open loop controller

c) either open loop or closed loop controller

d) similar controller as by Hamilton-Jacobi approach.

vi) Fuzzy logic control is applied when

    a)   mathematical model of the system is extremely difficult

    b)   there is ambiguity in information or data

    c)   there is involvement of human reasoning or decision making

    d)   all of these.

vii) Law of excluded middle can be represented for set A and B where X is the universe and ϕ is the empty set if

    a) $A \cap \overline{A} = \phi$ b) $A \cup \overline{A} = X$

    c) $A \cap X = A$ d) $A \cup \phi = X$.

viii) Knowledge base of the fuzzy logic controller consists of

    a)   only necessary information / data

    b)   only production rules

    c)   both rule base and data base

    d)   all of these.

ix) Stability by the direct method Lyapunov is applicable to

    a)   linear time invariant systems only

    b)   linear systems only

    c)   both linear and nonlinear systems

    d)   autonomous system only.

x) The definiteness of a Lyapunov function described by $V = x_1{}^2 + (x_2 + x_3)^2$ is found to be

    a)   positive definite   b)   positive semi-definite

    c)   indefinite   d)   negative semi-definite.

xi) MATLAB simulink provides fuzzy logic controller design using

    a)   Tagaki-Sugeno inference engine only

    b)   Mamdani inference engine only

    c)   both Sugeno and Mamdani inference engines

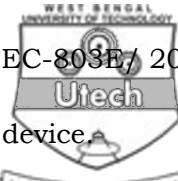   d)   Designed inference engine.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. Obtain Z-transform of $x(K) = 9K\,(2^{K-1}) - 2^K + 3$

for $K = 0, 1, 2, \ldots$ $x(K) = 0$ for $K < 0$.

3. Deduce transfer function of a zero order hold device.

4. Discuss steps for analytical approach of parameter optimization.

5. State and explain fundamental theorem of the calculus of variations.

6. Distinguish between crisp relation and fuzzy relation with suitable examples.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) A linear autonomous system is described by

$$\dot{X} = \begin{bmatrix} -4K & 4K \\ 2K & -6K \end{bmatrix} X .$$

Find restrictions on parameter K to guarantee stability of the system.

   b) Discuss with suitable example the use of Lyapunov function to estimate transient behaviour of dynamic system.   8 + 7

8. a) Explain the conditions to be satisfied for reconstruction of sampled signal into continuous signal.

   b) Find the range of K for the system shown below :
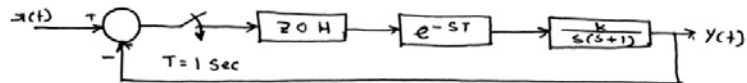
   $5 + 10$

9. a) The block diagram of a discrete data control system is shown where $G_p(s) = \dfrac{20}{s(s+5)}$ and $T = 5\cdot0$ sec. Compute and plot unit step response $C^x(t)$ of the system. Find step, ramp and parabolic error constants. Find also the final value of $C(KT)$.
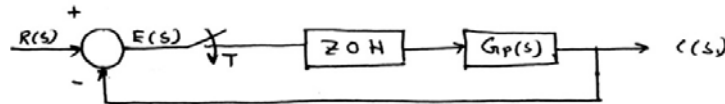
   b) Discuss the principle of state feedback design for discrete systems. $10 + 5$

10. a) For the system $\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$ assuming $U = -K^T X$, where $K = \begin{bmatrix} K_1 \\ K_2 \end{bmatrix}$, determine K_1 and K_2 so that performance index $J = \int_0^{\alpha} X^T X \, dt$ is minimized.

   Given $X(0) = \begin{bmatrix} \sqrt{2} \\ 0 \end{bmatrix}$ and underdamped natural frequency to be 2 rad /sec.

b) Explain Pontryagin's minimum principle as applied to optimal control system. 8 + 7

11. a) Illustrate with appropriate example the following :

   i) Distinction of crisp set and fuzzy set

   ii) Classical operators & fuzzy operators on fuzzy sets.

   b) What are the components of a fuzzy logic based controller ? Discuss the operations involved in the design of fuzzy control system. 7 + 8

12. Write short notes on any *three* of the following : 3 × 5

   a) Formulation of optimal control problem

   b) Riccati equation of continuous time linear state regulator

   c) Benefit and limitations of fuzzy control system

   d) Optimal controller for discrete systems.

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