Registration no: | | | | | | | | | | |

Total Number of Pages: 02 **M.TECH.**
PPPE204

2^{nd} Semester Back Examination 2016-17
ADVANCED CONTROL SYSTEMS
BRANCH: POWER ELECTRO AND POWER SYSTEMS
Time: 3 Hours
Max Marks: 70
Q.CODE:Z799
Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** (2 x 10)

a) Obtain the state-space representation of the following pulse-transfer function in controllable canonical form

$$\frac{Y(z)}{U(z)} = \frac{z^{-1} + 2z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

b) Comment on the state controllability of the pulse transfer function

$$\frac{Y(z)}{U(z)} = \frac{z + 0.2}{(Z + 0.8)(z + 0.2)}$$

Give reasons for your answer

c) What do you understand by deadbeat response? Can the concept of deadbeat control be applied to continuous-time systems?

d) What do you mean by a state estimator? Differentiate between a full-order and a reduced order observer

e) State the Quadratic optimal regulator control problem and define the terms used in the expression.

f) Determine variation of the functional

$$v = \int_0^1 2(x(t) + 2)^2 dt$$

g) What do you mean by 'sliding surface'?

h) Explain the term 'Supremum of a transfer function.'

i) What are the various T-norm and T-conorm operators?

j) For the fuzzy relation R,

$$R = \begin{bmatrix} 0.9 & 1.0 & 0 \\ 0.35 & 0.01 & 0.3 \\ 0.4 & 0.02 & 0.47 \\ 0.6 & 0.8 & 0.4 \\ 0.1 & 0 & 0.23 \\ 0.68 & 0.72 & 0.05 \end{bmatrix}$$

Find the strong λ-cut set relation for λ =0, 0.4.

Q2 a) Obtain the state transition matrix of the following discrete time system. (5)

$$X(k+1) = GX(k) + HU(k)$$
$$Y(k) = CX(k)$$

$$G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}, \quad H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

b) Determine $X(z)$ and $Y(z)$ for the system given in Q.No.2 (a) when the input $u(k) = 1$ for k=0,1.2….. (5)

Assume that the initial state is given by

$$X(0) = \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

Q3 a) Write down the conditions for asymptotic stability of a discrete-time system and derive the same for a system given by $X(k+1) = GX(k)$, if the Lyapunov function is chosen as $V\big(X(k)\big) = X^T(k)PX(k)$ (5)

b) Consider the system given by $\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.5 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$ (5)

Determine the stability at the origin of the system. Choose $Q = I$.

Q4 Consider the following model of a dynamic system: (5x2)

$\dot{x} = 2u_1 + 2u_2$ $\quad x(0) = 3,$ along with the performance index

$j = \int_0^\infty (x^2 + ru_1{}^2 + ru_2{}^2)\, dt,$

where $r > 0$ is a parameter.

(a) Solve the ARE corresponding to the linear state feedback optimal controller.

(b) Write the equation of the closed loop system driven by the optimal controller

Q5 Write down the Algebraic Ricatti Equation. Solve the ARE and find the optimal control gain for the following system described by A and B matrices and LQR performance criteria measured by Q and R. (10)

$$A = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \quad Q = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \quad R = 1$$

Q6 a) What do you mean by a variable structure system? Give an example of a variable structure system and show by neat sketches how the system can be made to have a characteristic which is not a property of any of the structures. (5)

b) Describe about Popov's stability criterion for non-linear systems. (5)

Q7 a) For speed control of a dc motor, the membership functions of series resistance, armature current and speed are given as follows: (6)

$$R_{se} = \left\{\frac{0.4}{30} + \frac{0.6}{60} + \frac{1.0}{100} + \frac{0.1}{120}\right\}$$

$$I_a = \left\{\frac{0.2}{20} + \frac{0.3}{40} + \frac{0.6}{60} + \frac{0.8}{80} + \frac{1.0}{100} + \frac{0.2}{120}\right\}$$

$$N = \left\{\frac{0.35}{500} + \frac{0.67}{1000} + \frac{0.97}{1500} + \frac{0.25}{1800}\right\}$$

Compute relation T for relating the series resistance to motor speed. Use max-min composition

b) If the fuzzy sets A and B are given by the following: (4)

$A = \{x_1, 0.5), (x_2, 0.7), (x_3, 0)\}$

$B = \{x_1, 0.8), (x_2, 0.2), (x_3, 1)\}$

Find out $A \cup B, A \cap \bar{B}, \overline{A^2}$ and $\bar{A}.\bar{B}$

Q8 **Write short notes on any two** (5 x 2)

a) Sugeno Fuzzy Inference System

b) Defuzzification methods

c) Model Reference Adaptive Controller

d) Self-tuning Regulator