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BIEEE-017

B.Tech. – VIEP – ELECTRICAL ENGINEERING (BTELVI)

Term-End Examination

00359

December, 2017

BIEEE-017 : ADVANCED CONTROL SYSTEM

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions. All questions carry equal marks. Symbols used have their usual meaning.*

1. (a) Derive the solution of non-homogeneous state equations. 7

(b) Express the following transfer function in controllable canonical form and observable canonical form. Also find eigenvalues for both cases and comment. 7

$$\frac{Y(s)}{U(s)} = \frac{5s^2 + 2s + 6}{s^3 + 7s^2 + 11s + 8}$$

2. (a) Explain why a state observer is required in control design. Draw and explain about Full-Order State Observers. 7

(b) Explain controller design using Pole-placement method. A regulator system is defined by $\frac{Y(s)}{U(s)} = \frac{10}{(s+1)(s+2)(s+3)}$. It is desired to place the closed-loop poles at $s = -2 + j2\sqrt{3}$, $s = -2 - j2\sqrt{3}$, $s = -10$. Obtain the necessary state-feedback gain matrix. 7

3. (a) Draw and explain the structure of a closed-loop digital control system. 7

(b) With neat sketches explain the principle of Sample and Hold circuit. Draw the magnitude and phase plot of the Zero-Order Hold. 7

4. (a) A discrete-time system is described by

$$y(k+2) + \frac{1}{4}y(k+1) - \frac{1}{8}y(k) = 3r(k+1) - r(k)$$

with input $r(k) = (-1)^k u(k)$ and initial conditions $y(-1) = 5$, $y(-2) = -6$. Find the output $y(k)$ for $k \geqslant 0$. 7

(b) A discrete-time system is represented by the state model

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -0{\cdot}16 & 1 \end{bmatrix} x(u) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} r(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k), \; x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}.$$ Determine the discrete-unit step response. Also find the pulse transfer function. 7

5. (a) State and explain the Lyapunov stability theorem for a continuous time system. 7

(b) What is a Describing Function ? Explain how an On-Off element with dead-zone can be analyzed using the describing function method. 7

6. (a) Explain Pontryagin's Minimum Principle. 7

(b) Given a double integrator system

$$x_1^0(t) = x_2(t) \qquad x_2^0(t) = u(t)$$

and the performance index as

$$J = \frac{1}{2}\int_{t_0}^{t_f} u^2(t)\, dt$$

find the optimal control and optimal trajectory, given the boundary condition as $X(0) = [1 \quad 2]^T$, $X(2) = [1 \quad 0]^T$. 7

7. (a) What is Artificial Neural Network (ANN) ? Explain multilayer feedforward model of ANN and describe the function of each layer. 7

(b) Explain the concept of Phase Plane Analysis. Using the concept of isoclines, construct a phase plane trajectory for system $\frac{d^2x}{dt^2} + \frac{dx}{dt} + x = 0$. 7

8. Write short notes on any ***two*** of the following : *2×7=14*

(a) Controllability and Observability

(b) Genetic Algorithm

(c) Routh-Hurwitz Criterion on r-planes