U.S.N | | | | | | | | | | |

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. – Electrical and Electronics Engineering

Semester End Examination; June - 2016

Modern Control Theory

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Derive the transfer function of, i) Two and ii) Three operational amplifier circuit realization of the PI and PD controller with the circuits. 10

b. What are the effects of different terms such as transmittance, steady state error, relative stability, type number, and system order for P, I, PI, PD and PID controllers. 10

2 a. Discuss the effects and limitations of, i) LEAD ii) LAG compensators. 12

b. Explain the improvements in the step and ramp responses for systems with and without (lead, lag and lag-lead) compensators. 8

UNIT - II

3 a. Compare the modern control theory with the conventional control theory. 4

b. For the system equations : 6

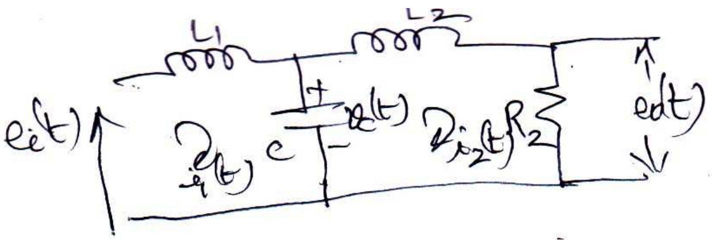
$\dot{x}_1 = x_2$

$\dot{x}_2 = x_3 + u_2$

$\dot{x}_3 = -2x_1 - 4x_2 - 6x_3 + u_1$; *and* $\dot{y}_1 = x_1$ *and* $y_2 = x_2$

Determine the transfer matrix.

c. Derive the state model for the electrical circuit shown in Figure. Choosing $i_1(t), i_2(t)$ *and* $v_c(t)$ are the state variables. 10



4 a. For the system , 8

$\dddot{y} + 9\ddot{y} + 26\dot{y} + 24 = 2\dot{u} + 10u$ Obtain the diagonal canonical state model and draw the block diagram.

Contd…2

b. Consider the following state model and output equation,

$$\begin{bmatrix} \overset{\circ}{x}_1 \\ \overset{\circ}{x}_2 \\ \overset{\circ}{x}_3 \end{bmatrix} = \begin{bmatrix} -6 & 1 & 0 \\ -11 & 0 & 1 \\ -6 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 2 \\ 6 \\ 2 \end{bmatrix} u,$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$ 12

Show that the state equation can be transformed into the following, form by the use of a proper transformation matrix. $\begin{bmatrix} \overset{\circ}{z}_1 \\ \overset{\circ}{z}_2 \\ \overset{\circ}{z}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -6 \\ 1 & 0 & -11 \\ 0 & 1 & -6 \end{bmatrix} \begin{bmatrix} z_1 \\ z_2 \\ z_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u$

And then obtain output 'y' interms of z_1, z_2, and z_3.

UNIT - III

5 a. Determine the response $y(t)$ for the system with,

$A = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix}; B = \begin{bmatrix} 0.5 \\ 0 \end{bmatrix}; C = \begin{bmatrix} 1 & 0 \end{bmatrix}$ and $\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$; and $u(t) = 1$ is the unit step i/p occur at t = 0. 12

b. State and prove Cayley-Hamilton theorem. 8

6 a. Consider the system with $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix}$; $B = \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$; $C = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ 12

Is the system is completely output controllable and completely observable?

b. Write an explanatory note on stabilizability, detectability and principle of duality as applied to controllability and observability. 8

UNIT - IV

7 a. Explain the Control system design via pole placement technique using state feedback and determine the state feedback gain matrix 'K' by anyone method. 12

b. The plant is given by $\dot{X} = AX + Bu$, where

$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}; u = -Kx$ The desired closed loop poles are at $S = -2 \pm j4$ *and* $S = -10$. Determine the state feedback gain matrix 'K' for the regulator system. 8

8 a. What is state observer and explain the need for state observer? Explain any one method to evaluate the state observer gain matrix Ke. 10

b. For the system $\mathring{x} = Ax + Bu$ *and* $y = Cx$, $A = \begin{bmatrix} 0 & 20.6 \\ 1 & 0 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = \begin{bmatrix} 0 & 1 \end{bmatrix}$ with $u = -k\hat{x}$ and assume the derived Eigen values are $\mu_1 = -10$ and $\mu_2 = -10$. Determine K_e (Use any method). 10

UNIT - V

9 a. Check the definiteness of the scalar function $V(x) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$. 8

b. Explain the stability in the sense of Liapunov, Asymptotic, stability, Asymptotic stability in the large and Instability with graphical representation. 12

10 a. State and prove Krasavskii's theorem. 6

b. Write a note on Liapunov stability analysis of LTI systems. 6

c. With the equilibrium state at the origin, determine the stability of the state with $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$ and determine the Liapunov function $V(x)$ *and* $\mathring{V}(x)$. 8

* * * *