Seat No.: ________ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2161707 **Date:10/05/2019**

Subject Name:Control System Design

Time:10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

MARKS

Q.1 **(a)** Derive state space model of series RLC circuit. **03**

(b) Check for observability of a system having following coefficient matrices using Kalmann's test. **04**

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -24 & -26 & -9 \end{bmatrix}, \ B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \ and \ C = \begin{bmatrix} 2 & 1 & 0 \end{bmatrix}$$

(c) Perform diagonalization of a given matrix A **07**

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}$$

Q.2 **(a)** Discuss about the advantages of state space method over conventional method. **03**

(b) Give the design steps of lag compensator in frequency domain. **04**

(c) Obtain the time response of the following system **07**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

where u(t) is a unit step occurring at t = 0 and $x^T(0) = [1\ 0]$.

OR

(c) State and derive Ackermann's formula for determination of the state feedback gain matrix K. **07**

Q.3 **(a)** What is state transition matrix? Give its properties. **03**

(b) Obtain the transfer function for the control system having state space model as **04**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} -4 & -1 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 2 \end{bmatrix} u$$

$$y = \begin{bmatrix} 2 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(c) Describe the parameters that are used to analyze the robustness of control systems. **07**

OR

Q.3 **(a)** Discuss the various Uncertainties in Parameter variation for robust control system design. **03**

(b) Write steps to design a lead-lag compensator for a given system in frequency domain. **04**

(c) The open-loop transfer function of a unity feedback control system is given by **07**

$$G(s) = \frac{K}{s\,(1 + 0.2s)}$$

Design a suitable compensator in frequency domain for $K_v = 10$ and PM = 50^o.

Q.4 **(a)** Find $F(A) = e^{At}$ for given matrix A using Cayley-Hamilton technique. **03**

$$A = \begin{bmatrix} 0 & -1 \\ 2 & 3 \end{bmatrix}$$

(b) Derive the transfer function of lead compensator using electrical network. **04**

(c) Write a short note on the design of robust PID controlled system. **07**

OR

Q.4 **(a)** Write a short note on Internal Model design. **03**

(b) Discuss about systems with prefilter. **04**

(c) The open loop transfer function of a unity feedback system is **07**

$$G(s)H(s) = \frac{K}{s(s+4)(s+5)}$$

Design a suitable lag compensator using root locus technique for velocity constant ≥ 5 and damping ratio = 0.707.

Q.5 **(a)** Explain positive definite and negative semi definite function. **03**

(b) Discuss about Lyapunov's stability criteria. **04**

(c) Explain LQR and Riccatti equation. **07**

OR

Q.5 **(a)** Describe the design of dead beat response with example. **03**

(b) Discuss about the considerations to be kept in mind while designing the robust control system **04**

(c) Explain Optimal Control Design. **07**

****