KUMARAGURU
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B.E DEGREE EXAMINATIONS: NOV/DEC 2022

(Regulation 2018)

Seventh Semester

ELECTRONICS & INSTRUMENTATION ENGINEERING

U18EII7202**:** Advanced Control Systems

COURSE OUTCOMES

CO1: Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers. (K4)

CO2: Analyse non-linear system behavior by phase plane and describing function methods. (K4)

CO3: Perform stability analysis of non-linear systems. (K4)

CO4: Evaluate performance measures for optimal control problem and design a robust control system. (K4)

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1. Mention the ways in which a state model can be represented.   CO1 [K$_1$]

2. If A= $\begin{bmatrix} \alpha & 0 \\ 0 & \alpha \end{bmatrix}$, compute the state transition matrix, e^{At}.   CO1 [K$_3$]

3. What is similarity transformation?   CO1 [K$_2$]

4. Classify the nonlinearities with examples.   CO2 [K$_2$]

5. What is describing function?   CO2 [K$_2$]

6. How will you determine the stable and unstable limit cycles using phase portrait?   CO2 [K$_2$]

7. How is the definiteness of a quadratic function determined?   CO3 [K$_3$]

8. What is stability in the sense of Lyapunov?   CO3 [K$_2$]

9. What do you mean by optimal control?   CO4 [K$_2$]

10. How the desired performance in the presence of significant uncertainty is exhibited?   CO4 [K$_1$]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a)   Determine the transfer function of a system which is governed by the following   8   CO1 [K$_3$]
state equation:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 0 & 1 \\ 4 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b)   Obtain the Vander Monde matrix of a dynamic system whose   8   CO1   [K3]

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$$

12.   Comment on the controllability and observability for the following system: 16   CO1   [K3]

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \qquad\qquad Y = \begin{bmatrix} 0 & 1 & -1 \end{bmatrix} X$$

13.   Using a suitable graphical method, draw the phase trajectory for the system,   16   CO2   [K4]

$$\frac{d^2 x}{dt^2} + 0.6 \frac{dx}{dt} + x = 0$$

with x = 1 and $\dfrac{dx}{dt} = 0$ as initial condition. Also comment on the stability.

14. a)   What are the types of relays used for the analysis of describing function analysis?   6   CO2   [K2]
Draw their characteristics.

    b)   For the following double clipper circuit, the input - output waveforms are shown.   10   CO2   [K4]
Identify the nonlinearities and draw the combined input - output characteristics.
Also derive the describing function for the same.

Input waveform   Output waveform
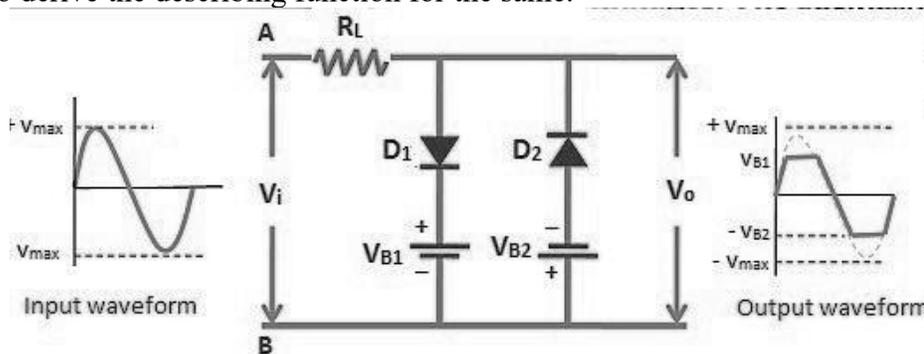
15.   Investigate the stability of the system described by the following equation using a   16   CO3   [K4]
suitable method:

$$\dot{x}_1 = x_2 - x_1 (x_1^2 + x_2^2)$$
$$\dot{x}_2 = -x_1 - x_2 (x_1^2 + x_2^2)$$

16.   Obtain the optimal control law by Ricatti equation for a continuous time system.   16   CO4   [K3]

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