Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2023

Semester : Semester III - 2021
Course Code : EEE3052
Course Name : Sem III - EEE3052 - Control Systems for Robotic Applications
Program : B.Tech. - ISR

Date : 11-JAN-2023
Time : 1.00PM - 4.00PM
Max Marks : 100
Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.

PART A

ANSWER ALL THE TEN QUESTIONS **10 X 2 = 20M**

1. List any two methods to determine the stability of a linear time invariant system.

(CO1) [Knowledge]

2. The performance characteristics of a control system are specified in terms of the transient response to unit step input. The transient response of a practical control system exhibits damped oscillations before attaining the steady state. Define the following performance indices with respect to the step response of a second order system.

(a) Rise time (b) Peak time

(CO1) [Knowledge]

3. For analyzing and designing control systems, we must have a basis of comparison for time response of various control systems. This is accomplished by subjecting the systems to be compared with the typical test signals and recording the time responses. List 2 commonly used test signals with their mathematical representation and Laplace transform

(CO2) [Knowledge]

4. The error constants Kp, Kv and Ka describe the ability of a system to reduce or eliminate steady state errors. List the expressions for the various error constants

(CO2) [Knowledge]

5. Suggest a suitable test to check the controllability and observability and explain the procedure

(CO3) [Knowledge]

6. List the Qc and Qo matrix in Kalman's test

(CO3) [Knowledge]

7. Define the terms controllability and observability

(CO3) [Knowledge]

8. Draw the block diagram representation of a PI controller

(CO4) [Knowledge]

9. List the difference between state feedback and output feedback

(CO4) [Knowledge]

10. Describe the procedure to obtain the transfer function from the state model

(CO3) [Knowledge]

PART B

ANSWER ALL THE FIVE QUESTIONS **5 X 10 = 50M**

11. Rotational mechanical systems move about a fixed axis. A disc of moment of inertia J is rotated with an applied torque of T Nm. The disc is fixed at one end using an elastic shaft. Assuming the disc can be modelled using moment of inertia J, Damper B and spring constant K, obtain its mathematical model.

(CO1) [Comprehension]

12. A controller is to be designed for a system which has an electric motor. The transient response of the control system has to be improved such that overshoot is minimum and settling time is less which improves the life and performance of the motor.Suggest a suitable controller and explain with its block diagram.

(CO2) [Comprehension]

13. A closed loop control system with order three is represented by the differential equation given below.Construct a state model for the system

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$$

(CO3) [Comprehension]

14. An autonomous mobile robot used in an automobile industry is required to carry some raw materials from one location to another through a predefined path. It is required that the robot should follow the path without any deviation or error. Suggest a suitable controller for the above robot control system which should be economical also.

(CO4) [Comprehension]

15. Identify the test signals which give constant steady state error with type 0, type 1 and type 2 signals . Write down the expression for their steady state errors.

(CO2) [Comprehension]

PART C

ANSWER ALL THE TWO QUESTIONS **2 X 15 = 30M**

16. For a single input singleoutput system given below apply suitable test and check the controllability and observability

$$\dot{X} = AX + BU$$
$$Y = CX$$
$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix};\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix};\ C = [1 \quad 1]$$

(CO3) [Application]

17. Apply Lyapunov's Direct method and determine the stability of the system given below

$$\begin{bmatrix} -1 & -1 \\ -2 & -3 \end{bmatrix} x$$

(CO4) [Application]

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