B F192030 Pages:2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

Course Code: EE304

Course Name: ADVANCED CONTROL THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

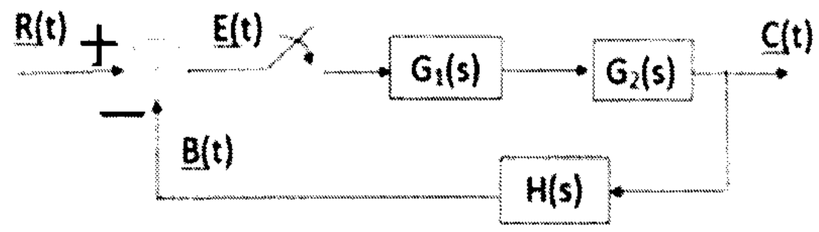
Answer all questions, each carries 5 marks. Marks

1 Obtain the transfer function of a lead compensator with the help of an electrical network. (5)

2 Derive the transfer function of a PID Controller (5)

3 Derive a relation between state equation and transfer function for LTI system. (5)

4 Obtain the pulse transfer function for the system shown below. (5)



5 With a neat diagram explain how the describing function analysis is used to determine the stability of a system? (5)

6 What are jump response and limit cycles in connection with nonlinear systems? (5)

7 Explain with neat diagram, what is phase trajectory and phase portrait? (5)

8 Define positive definite and positive semi definite functions according to Liapunov stability criteria, with suitable examples. (5)

PART B

Answer any two full questions, each carries 10 marks.

9 a) Draw the bode-plot of lag compensator and obtain an expression for maximum phase lag and corresponding frequency. (6)

b) Explain turning of PID controller using Ziegler-Nichols tuning method. (4)

10 Explain the procedure for design of a lag Compensator using Bode Plot with suitable example (10)

11 Consider a unity feedback system with open loop transfer function (10)

$$G(s) = \frac{k}{s(s+8)}$$

Design a lead compensator to meet the following specification:

1. Percentage peak overshoot is 9.5%
2. Natural frequency of oscillations 12 rad/sec
3. Velocity error constant ≥ 10

PART C

Answer any two full questions, each carries 10 marks.

12 a) A system is described by $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} x(t)$ (5)

Determine state transition matrix for the system.

b) Define controllability. Explain with a suitable example, how can we check the controllability of a system? (5)

13 Derive the state model of the following transfer function in, (10)

(i) Controllable canonical form

(ii) Diagonal canonical form

$$\frac{y(s)}{u(s)} = \frac{5(s+2)}{s(s+1)(s+3)}$$

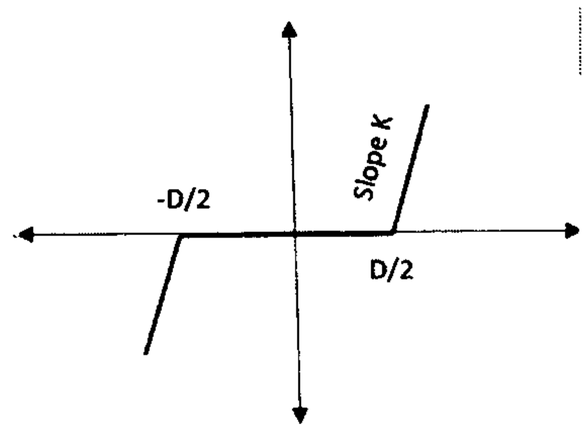
14 Examine the stability of the system with the following characteristic equation using Jury's stability test. (10)

$$z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$$

PART D

Answer any two full questions, each carries 10 marks.

15 Identify the following non linearity and derive a describing function for the same (10)



16 Consider the following non linear differential equation. (10)

$$\ddot{y} - \left(0.1 - \frac{10}{3}\dot{y}^2\right)\dot{y} + y + y^2 = 0$$

Find all singular points of the system, classify them and sketch the phase portrait in the neighbourhood of singular points.

17 a) Discuss any three non linearities present in nature. (6)

b) Investigate the stability of the following non-linear system using Liapunov direct method (4)

$\dot{x}_1 = x_2$

$\dot{x}_2 = -x_1 - x_1^2 x_2$.

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