

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Sixth semester B.Tech examinations (S), September 2020

**Course Code: EE304****Course Name: ADVANCED CONTROL THEORY**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 5 marks.*

Marks

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|---|--|-----|
| 1 | What is a PI controller? What are its effects on the system performance?                                       | (5) |
| 2 | What is a lead compensator? Obtain its frequency response characteristics                                      | (5) |
| 3 | What is state space? What are the advantages of state space analysis?  | (5) |
| 4 | What is pulse transfer function? What is the stability criterion of a sampled data control system?             | (5) |
| 5 | Mention any two characteristics of Nonlinear systems. What are limit cycles?                                   | (5) |
| 6 | Define Describing function. What is the difference between stability analysis of linear and nonlinear systems? | (5) |
| 7 | What is the difference between describing function and phase plane method of stability analysis?               | (5) |
| 8 | Explain Liapunov direct method of stability for nonlinear systems.   | (5) |

**PART B***Answer any two full questions, each carries 10 marks.*

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|----|--|------|
| 9  | The open loop transfer function of a unity feedback control system is given by $G(S) = K/[S(1+0.5S)(1+0.2S)]$ . It is desired that (i) the steady state error to unit ramp input is less than 0.125 (ii) Phase margin $\geq 30^\circ$ (iii) Gain margin $\geq 10$ db. Design a suitable compensator. | (10) |
| 10 | Design a suitable compensator for a unity feedback system with open loop transfer function $G(S) = K/[S(S+4)(S+7)]$ to satisfy the following specifications. (1) Percentage overshoot = 12.63% (2) Natural frequency of oscillation = 8 rad/sec (3) Velocity error constant $\geq 2.5$ .             | (10) |
| 11 | Explain the Ziegler-Nichols method of tuning a PID controller when (a) dynamic model is known (b) dynamic model is not known.  | (10) |

**PART C***Answer any two full questions, each carries 10 marks.*

- 12 a) Obtain the state model of the system whose transfer function is given by (5)  
 $Y(s)/U(s) = 10/[s^3 + 4s^2 + 2s + 1]$
- b) Obtain the state model of a field controlled DC motor. (5)
- 13 A discrete time system is described by the difference equation (10)  
 $y(k+2) + 5y(k+1) + 6y(k) = u(k)$   
 $y(0) = y(1) = 0; T = 1 \text{ sec.}$   
 (a) Determine state model in a canonical form (b) Find the state transition matrix
- 14 Check the stability of the sampled data control system with the following characteristic equation using Jury's stability test  $z^4 - 1.7z^3 + 1.04z^2 - 0.268z + 0.024 = 0$  (10)

**PART D***Answer any two full questions, each carries 10 marks.*

- 15 Derive the Describing function of saturation with deadzone. (10)
- 16 Construct the phase trajectory for the system (10)  
 $\dot{x}_1 = x_2, \dot{x}_2 = -\text{sign}(x_1)$  where  $\text{sign}(x_1) = \begin{cases} 1 & \text{for } x_1 > 0 \\ -1 & \text{for } x_1 \leq 0 \end{cases}$  starting from (2,0)
- 17 Test the stability of the system using Lyapunov stability theorem (10)  
 (a)  $\dot{x}_1 = -x_1 + 2x_1^2x_2, \dot{x}_2 = -x_2$   
 (b)  $\dot{x}_1 = x_2, \dot{x}_2 = -\sin(x_1) - x_2$

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