Register Number:……..

KUMARAGURU college of technology
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B.E DEGREE EXAMINATIONS: MAY 2018

(Regulation 2015)

Sixth Semester

ELECTRONICS AND INSTRUMENTATION ENGINEERING

U15EIT601**:** Advanced Control Systems

COURSE OUTCOMES

CO1: Develop state space model for a MIMO system.
CO2: Understand and apply different methods of test for controllability and observability of MIMO systems.
CO3: Analyze non-linear system stability using phase plane.
CO4: Derive describing function for nonlinearities.
CO5: Perform stability analysis of non-linear systems.
CO6: Understand advanced controllers for linear and non-linear systems.

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Matching type item with multiple choice code CO1 [K_1]

List I	List II
A. Conventional control theory	i. Observability
B. Initial Conditions of State space analysis	ii. SISO
C. state of dynamic system	iii. Non-zero
D. measurements at output	iv. State variables

	A	B	C	D
a)	ii	iii	iv	i
b)	iii	iv	ii	i
c)	ii	iv	iii	i
d)	iii	i	ii	iv

2. A transfer function of control system does not have pole-zero cancellation. Which one of the following statements is true? CO2 [K1]

a) System is neither controllable nor observable
b) System is completely controllable and observable
c) System is controllable but unobservable
d) System is observable but uncontrollable

3. Limit cycles are: CO3 [K2]

1.Oscillations of the response with fixed amplitude and frequency.

2. Output is proportional to input .

3. Oscillations when there is no input.

4. region in which the output is zero for a given input.

a) 1,3 b) 1,4

c) 1,2 d) 2,3

4. The coordinate plane with the state variables x_1 and x_2 as two axes is called the _____. CO3 [K_1]

a) Singular plane b) Phase plane

c) Saddle plane d) Vortex plane

5. Assertion (A):The describing function method is based on harmonic linearization. CO4 [K_3]

Reason (R):The degree of accuracy achieved is heavily dependent upon the filtering property of the linear part of the system.

a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false d) A is false but R is true

6. The stability of the limit cycle is can be judged by the _____ technique. CO5 [K_1]

a) hysteresis b) Jump resonance

c) Dead-zone d) perturbation

7. Sequencing type item CO5 [K_3]

1. Determine the region of stability where V is positive definite.
2. Determine V by integrating it.
3. Form the derivative of V.
4. Determine the remaining unknown.

a) 2-3-4-1 b) 1-3-2-4

c) 3-4-2-1 d) 4-1-3-2

8. The stability of non-linear systems: CO5 [K_1]

a) Disturbed steady state coming back to its equilibrium state b) Non-linear systems to be in closed trajectory

c) In limit cycles that is oscillations of the systems d) All of the mentioned

9. Assertion (A): A reference model is used to specify the ideal response of the adaptive control system to the external command. CO6 [K_3]

Reason (R): It should reflect the performance specifications in the control tasks, such as rise time, settling time, overshoot or equivalent frequency domain characteristics.

a) Both A and R are Individually true and R is the correct explanation of A

b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

10. _____ problem is a special case of tracking problem in which the setpoint r(t) is zero. CO6 [K_1]

a) State regulator

b) Control effort

c) Output regulator

d) Time related

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. Compute the eigen values of the system matrix given by CO1 [K_2]

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

12. Differentiate between linear and non-linear systems. CO1 [K_3]

13. Define: Limit cycles. CO3 [K_1]

14. Classify the types of singular points. CO3 [K_3]

15. Write the describing function of backlash nonlinearity. CO4 [K1]

16. Analyze how the stability of nonlinear system is determined in describing function technique. CO4 [K4]

17. List the conditions to be satisfied by a system to apply the popov's criterion. CO3 [K_3]

18. State the mathematical representation of Aizerman's conjecture. CO3 [K_3]

19. Specify the importance of internal model control. CO6 [K3]

20. Sketch the block diagram of state observer. CO6 [K1]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. The state model of the system is given by CO2 [K2]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Determine whether the system is controllable and observable.

22. A linear second order servo is described by the equation $\ddot{C} + 2\xi\omega_n\dot{C} + \omega_n^2 C = 0$ where ξ = 0.15, ω_n=1 rad/sec, C(0) = 1.5 and $\dot{C}$ = 0. Determine the singular point. Construct the phase trajectory using the method of isoclines. CO3 [K2]

23. Determine the describing function of saturation nonlinearity. CO4 [K2]

24. State the theorems of Liapunov's stability and the concept of Liapunov's direct method. CO5 [K3]

25. A system has the transfer function CO1 [K4]

$$\frac{Y(s)}{U(s)} = \frac{4s^3 - 12s^2 + 13s - 7}{(s-1)^2(s-2)}$$

Determine the state model of the system in (a) Phase variable form (b) Jordan canonical form.

26. Elaborate on the concept of model predictive controller. CO6 [K3]

27. Analyze the need for adaptive controller with its types. CO6 [K5]

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