Register Number:……..

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

(Regulation 2015)

Fourth Semester

**ELECTRICAL AND ELECTRONICS ENGINEERING**

U15EET403: Control Systems

(Provide Semilog sheet, Graph Sheet)

**COURSE OUTCOMES**

**CO1:** Gain basic knowledge about various control system components

**CO2:** Derive the transfer function model and state space model of physical systems

**CO3:** Determine the transient and steady state behavior of systems subjected to standard test signals

**CO4:** Analyze the linear systems for steady state errors

**CO5:** Analyze the linear systems for absolute and relative stability in time and frequency domain

**CO6:** Familiarize with system properties like controllability and observability

**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. Torque (T) | i. Inductance (L) |
| B. Moment of Inertia (J) | ii. Resistance (R) |
| C. Damping Coefficient (B) | iii. Voltage (E) |
| D. Angular velocity (ω) | iv. Current (i) |

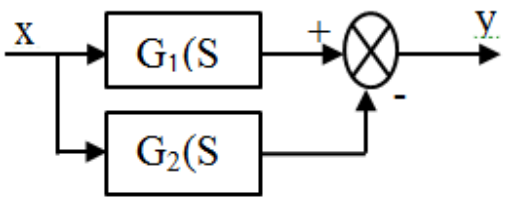
| | A | B | C | D |
|---|---|---|---|---|
| a) | iii | i | ii | iv |
| b) | i | ii | iii | iv |
| c) | ii | iv | i | iii |
| d) | iv | iii | i | ii |

2. In Torque-current analogy, Angular displacement is equivalent to CO1 [$K_1$]

a) Current (I) b) Capacitance (C)

c) Conductance (G) d) Flux Linkage (Φ)

3. Eliminating a forward loop results in CO2 [$K_2$]



a) (G1 – G2) b) (G2 – G1)
c) (G1 + G2) d) ($G_2 + G_1$)

4. The response of a 2nd under damped order system with unit step input is given as _____ CO3 [$K_2$]
a) Oscillation in nature b) Sinusoidally reducing Oscillation
c) Exponentially increasing nature d) Constant

5. The necessary and sufficient condition that a feedback system be stable is that CO5 [$K_2$]
A. All the poles of the overall transfer function have negative real part
B. All the poles of the overall transfer function have positive real part
C. All the poles and zeros of the overall transfer function have positive real part
a) A is true b) B is true
c) C is true d) B and A is true

6. If a pole is added to a II-order system, Bandwidth, Rise time and Resonant Peak CO3 [$K_2$]
a) All Increases b) Increases, Decrease, Decrease
c) Decrease, Increase, Increase d) All Decrease

7. The reduction of blocks is possible by the following sequences CO2 [$K_2$]
1. Reduce the parallel block
2. Reduce the minor feedback loop.
3. Reduce the series block.
4. Shift the summing point to the left and takeoff point to the right, as far as possible
a) 2-3-4-1 b) 1-3-2-4
c) 3-4-2-1 d) 3-1-2-4

8. The system characterized by the equation $2S^4 + 2S^3 + S^2 + 3S + 2 = 0$ is CO4 [$K_3$]
a) Unstable b) Stable
c) Marginally stable d) Marginally unstable

9. Assertion (A): Routh-Hurwitz criterion is applicable only for linear systems. CO5 [$K_2$]
Reason (R): It provides the exact location of closed loop poles in left or right half of S-plane
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. The state transition matrix when $A = \begin{bmatrix} -1 & 1 \\ 0 & 2 \end{bmatrix}$ is CO1 [$K_2$]
a) $\varphi(t) = \begin{bmatrix} e^{-t} & e^{-t} - e^{-2t} \\ e^{-t} & e^{-2t} \end{bmatrix}$ b) $\varphi(t) = \begin{bmatrix} e^{-t} & e^{-t} + e^{-2t} \\ 0 & e^{-2t} \end{bmatrix}$
c) $\varphi(t) = \begin{bmatrix} e^{-t} & e^{-t} - e^{-2t} \\ 0 & e^{-2t} \end{bmatrix}$ d) $\varphi(t) = \begin{bmatrix} e^{t} & e^{t} - e^{2t} \\ e^{t} & e^{2t} \end{bmatrix}$

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

11. What is transfer function of a system? CO1 [$K_1$]
12. Define types and order of a system. CO1 [$K_1$]
13. State Masons gain formula. CO2 [$K_2$]
14. What is the response of a second order system for unit step input and classify the systems based on the damping ratio. CO3 [$K_2$]

15. The forward path transfer function of a unity feedback control system is given by $G(s)=\frac{5(S^2+2S+100)}{S^2+(S+5)(S^2+3S+10)}$. Determine the step, ramp and parabolic error coefficients. Also determine the type of the system . CO4 [$K_3$]

16. Sketch the polar plot for G(s)=1/s2 . CO5 [$K_3$]

17. Define phase margin and gain margin of a system. CO5 [$K_3$]

18. Check the stability of the system, having following characteristic equation CO5 [$K_2$]

$S^5+6S^4+3S^3+2S^2+s+1=0$

19. Consider the following system CO6 [$K_3$]

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-0.5 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

$$[y(t)]=[0 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

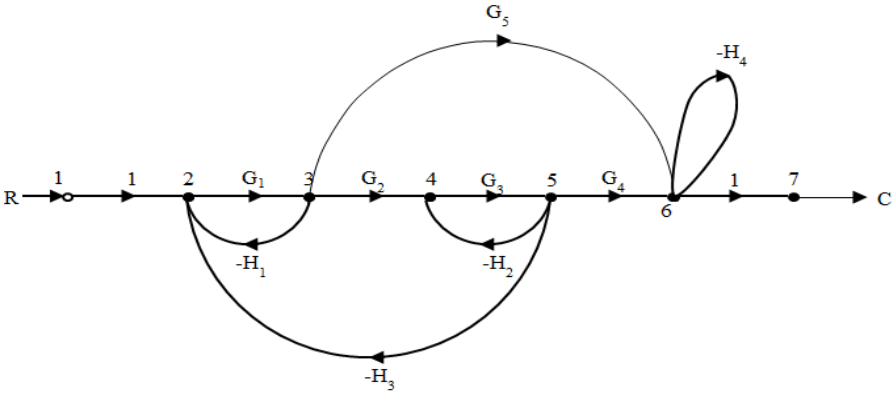
Test for controllability and observability

20. What are the differences between state space modelling in physical variable & Canonical variable form? CO2 [$K_2$]

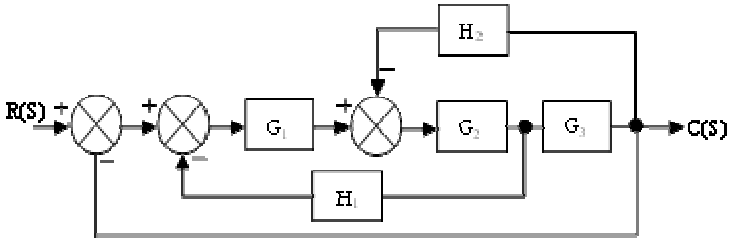
**Answer any FIVE Questions:-**
**PART C (5 x 14 = 70 Marks)**
**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

21. For the given signal flow graph find the ratio C/R. CO2 [$K_2$]




22. Determine the ratio C(S)/R(S) for the system given below CO2 [$K_2$]



23.(a) When the second order control system is subjected to a unit step input, the values of $\zeta = 0.5$ and $\omega n = 6 rad/\sec$. Determine the rise time, peak time, settling time and Peak overshoot. (7) CO3 [$K_2$]

(b) Consider a unity feedback control system with the closed loop transfer function $\frac{C(S)}{R(S)} = \frac{KS+b}{S^2+aS+b}$ Determine the open loop transfer function. Show th the steady state error in the unit ramp input response is given by $e_{ss} = \frac{a-k}{b}$ (7) CO4 [$K_3$]

24. Sketch the Bode plot for the transfer function $G(S) = \frac{1000}{S(1+0.1S)(1+0.01S)}$. Determine Gain cross over frequency, phase cross over frequency, gain margin, phase margin and stability of the system. CO5 [$K_3$]

25. Draw the root locus of a unity feedback closed loop system for $S^4 + 2S^3 + (4+K)S^2 + 9S + 25 = 0$ CO5 [$K_3$]

26. Using Routh stability criterion, find range of K for system to be stable. CO5 [$K_3$]

is $G(S) = \frac{K}{S(S+1)(S+4)}$ to meet following specification Damping ratio = 0. Settling time $t_s$=10sec and Velocity error constant $K_V \geq 5$.

27. A system characterized by the transfer function $\frac{Y(S)}{U(S)} = \frac{2}{S^3+6S^2+11S+6}$. Find the state and output equation in matrix form. CO6 [$K_2$]

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