SIDDHARTH GROUP OF INSTITUTIONS :: PUTTUR
(AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583
QUESTION BANK (DESCRIPTIVE)

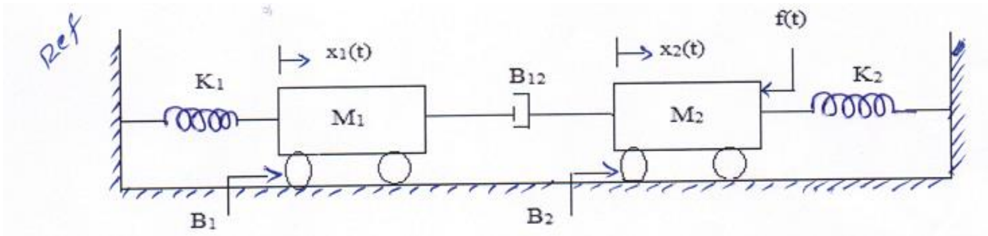
Subject with Code : Linear Control Systems (16EE216) **Course & Branch**: B.Tech– EEE&ECE

Year &Sem: III-B.Tech& I-Sem **Regulation:** R16

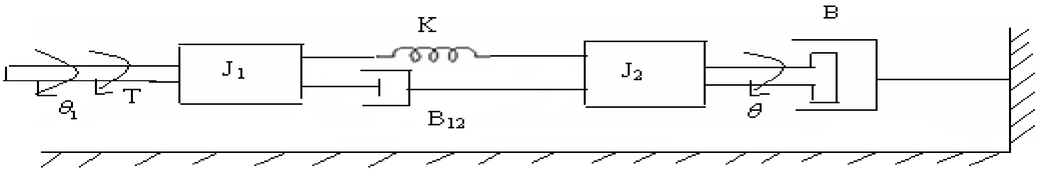
UNIT –I

CONTROL SYSTEMS CONCEPTS

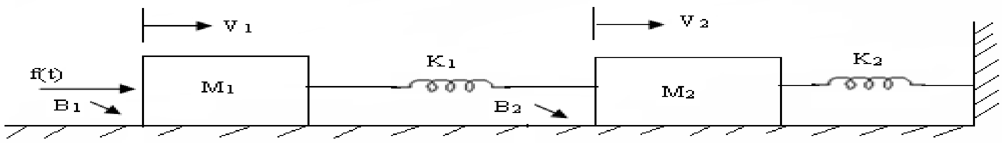
Q.1 For the mechanical system shown in Fig, derive the transfer functions $\frac{X1(s)}{F(s)}$ & $\frac{X2(s)}{F(s)}$ 12M



Q.2 Write the differential equations governing the mechanical rotational system shown in the figure and find transfer function. 12M



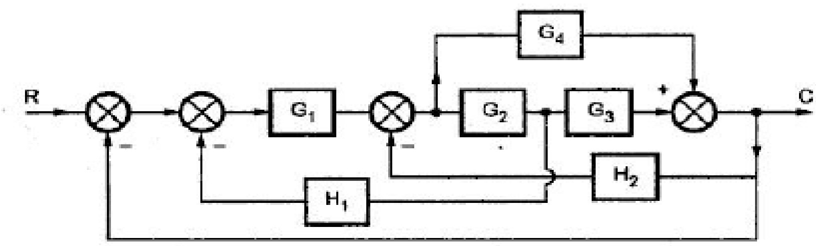
Q.3 For the mechanical system shown in the figure draw the force-voltage and force-current analogous circuits. 12M



Q.4 a. Deduce the transfer function for Armature controlled DC servo motor with neat diagram? 8M

b. Distinguish between Block diagram Reduction Technique and Signal Flow Graph? 4M

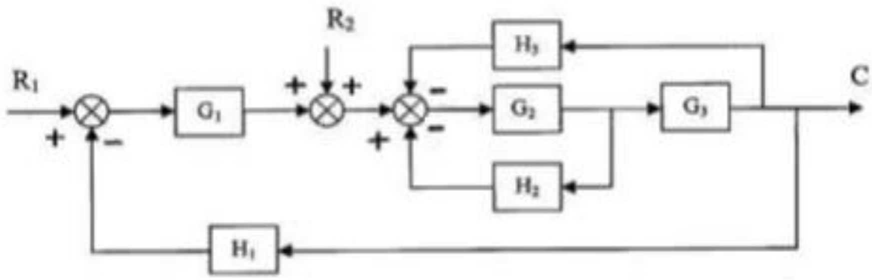
Q.5 Using Block diagram reduction technique find the Transfer Function of the system. 12M



Q.6 a. Derive the transfer function for A.C servo motor with neat diagram? 8M

b. Derive the transfer function for synchro with neat diagram? 4M

Q.7 For the system represented in the given figure, obtain transfer function:(a)$\frac{C}{R1}$ (b)$\frac{C}{R2}$ 12M



Q.8 Construct the signal flow graph for the given set of algebraic equations and find the overall Gain using Mason gain formula. 12M

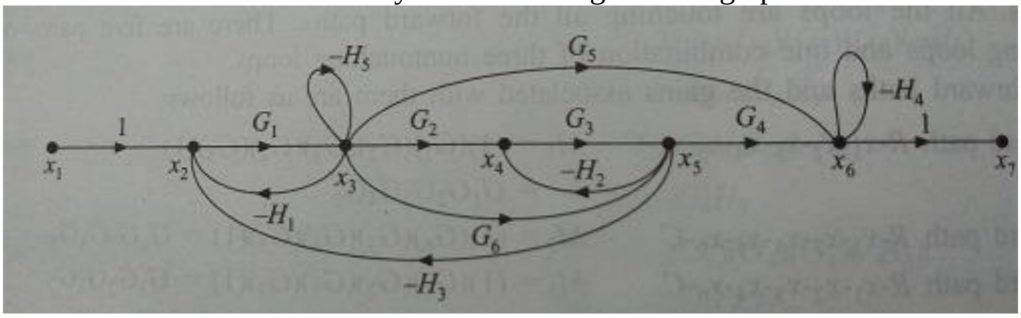
$X_2 = a_{12} X_1 + a_{22} X_2 + a_{32} X_3 + a_{42} X_4 + a_{52} X_5$

$X_3 = a_{23} X_2$

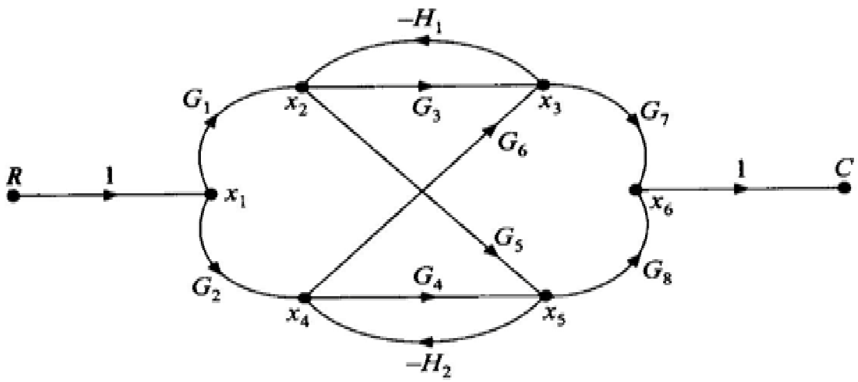
$X_4 = a_{34} X_3 + a_{44} X_4$

$X_5 = a_{35} X_3 + a_{45} X_4$

Q.9 Obtain the transfer function of the system whose signal flow graph is shown below. 12M



Q.10 Using mason gain formula find the transfer function $\frac{C}{R}$ for the signal flow graph shown in figure. 12M



UNIT-II

TIME RESPONSE ANALYSIS

Q.1 List out the time domain specifications and derive the expressions for Rise time, Peak time and Peak overshoot. 12M

Q.2 Find all the time domain specifications for a unity feedback control system whose open loop transfer function is given by **G(S) =** $\frac{25}{S(S+5)}$. 12M

Q.3 A closed loop servo is represented by the differential equation: $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$. Where 'c' is the displacement of the output shaft, 'r' is the displacement of the input shaft and e =r – c. Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input. 12M

Q.4 a. Measurements conducted on a servo mechanism, show the system response to be $c(t) = 1+0.2e^{-60t} - 1.2e^{-10t}$ When subject to a unit step input. Obtain an expression for closed loop transfer function, determine the undamped natural frequency, damping ratio? 6M

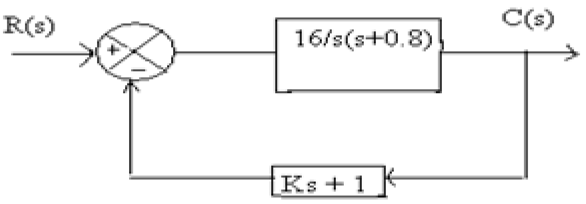
b. For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. 6M

$$G(s)H(s)=\frac{10}{S^2(S+1)(S+2)}.$$

Q.5 A unity feedback control system has an open loop transfer function, **G(s) =** $\frac{10}{S(S+2)}$. Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units. 12M

Q.6 What is meant steady state error? Derive the static error components for Type 0, Type 1 &Type 2 systems? 12M

Q.7 A positional control system with velocity feedback shown in figure. What is the response c(t) to the unit step input. Given that damping ratio=0.5.Also calculate rise time, peak time, maximum overshoot and settling time. 12M



Q.8 a. A For servo mechanisms with open loop transfer function given below what type of input signal give rise to a constant steady state error and calculate their values. 6M

$$G(s)H(s)=\frac{20(S+2)}{S(S+1)(S+3)}$$

b. Consider a unity feedback system with a closed loop transfer function $\frac{C(S)}{R(S)} = \frac{KS+b}{(S^2+aS+b)}$. Determine open loop transfer function G(s). Show that steady state error with unit ramp input is given by $\frac{(a-K)}{b}$ 6M

Q.9 For a unity feedback control system the open loop transfer function **G(S)** = $\frac{10(S+2)}{S^2(S+1)}$. 12M

(i) Find the position, velocity and acceleration error constants.

(ii) The steady state error when the input is **R(S)** = $\frac{3}{S} - \frac{2}{S^2} + \frac{1}{3S^3}$.

Q.10 a. What is the characteristic equation? List the significance of characteristic equation. 4M

b. The system has **G(s)** = $\frac{K}{S(1+ST)}$ with unity feedback where K & T are constant. Determine the factor by which gain **'K'** should be multiplied to reduce the overshot from **75%** to **25%?** 8M

UNIT –III

STABILITY ANALYSIS IN CONTROL SYSTEMS

Q.1 With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations:

(a) $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$. 3M

(b) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. 6M

(c) $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$. 3M

Q.2 **a.** The open loop transfer function of a unity feedback system is given by 8M

$G(s) = \frac{K(S+1)}{(S^3+aS^2+2S+1)}$. Determine the value of 'K' and 'a' so that the system oscillates at a frequency of 2 rad/sec.

b. Explain the effect of adding poles and zeros to characteristic equation on stability of the root loci. 4M

Q.3 The open loop Transfer function of a unity feedback control system is given by 12M

$G(s)H(s) = \frac{K}{(S+2)(S+4)(S^2+6S+25)}$ Determine the value of K which will cause sustained oscillationsin the closed loop system and what is the corresponding oscillation Frequency.

Q.4 Using Routh's criteria determine the stability of following system.

(a) It's open loop transfer function has poles at s = 0, s = -1, s = -3 and zeros at s = -5, Gain k of forward path is "10" 6M

(b) It is a type-1 system, with an error constant of 10 sec^{-1} and poles at s = -3 & s = - 6. 6M

Q.5 Sketch the root locus of the system whose open loop transfer function is 12M

$G(s)H(s) = \frac{K}{S(S+2)(S+4)}$.Find the value of 'K' so that the damping ratio of closed loop system is 0.5.

Q.6 Sketch the root locus of the system whose open loop transfer function is 12M

$$G(s)H(s) = \frac{K}{S(S+4)(S^2+4S+20)}$$

Q.7 Sketch the root locus of the system whose open loop transfer function is 12M

$$G(s)H(s) = \frac{K(S+1.5)}{S(S+1)(S+5)}.$$

Q.8 Sketch the root locus of the system whose open loop transfer function is 12M

$$G(s)H(s) = \frac{K(S^2+6S+25)}{S(S+1)(S+2)}$$

Q.9 Sketch the root locus of the system whose open loop transfer function is 12M

$$G(s)H(s) = \frac{K(S+2)}{S(S-2)(S^2+5S+16)}$$

Q.10 The characteristic equation of a feedback control system is $s^4+3s^3+12s^2+(K-16)s+K=0$ 12M
Sketch the root locus plot for 0<K< infinity. Determine the range of gain for which the system is stable.

UNIT-IV

FREQUENCY RESPONSE ANALYSIS

Q.1 Sketch the Bode plot for the following transfer function **G(s)H(s)** = $\frac{K e^{-0.1s}}{S(S+1)(1+0.1S)}$ 12M

a) What is the value of K for the $\mathbf{w_{gc}}$ to be 0.5 rad/sec. For this value of K, what is the PM?

b) What is the value of K for the $\mathbf{w_{gc}}$ to be 5 rad/sec. For this value of K, what is the PM?

Q.2 a. Band width is directly proportional to ω_n. Justify. 4M

b. Draw the Bode plot for the system having the following transfer function 8M

$$G(s) = \frac{15(S+5)}{S(S^2 + 16S + 100)}$$

Q.3 a. Define and derive the expression for resonant frequency. 6M

b. Draw the magnitude bode plot for the system having the following transfer function: 6M

$$G(s)\,H(s) = \frac{2000(S+1)}{S(S+10)(S+40)}$$

Q.4 Derive the expressions for resonant peak and resonant frequency and hence establish the correlation between time response and frequency response. 12M

Q.5 Draw the Bode plot for the following Transfer Function **G(s) H(s)** = $\frac{36(0.1S+1)}{S^2(0.2S+1)(0.02S+1)}$ 12M

From the bode plot determine (a) Gain Margin (b) Phase Margin (c) Comment on the stability

Q.6 a. Given $\xi = \mathbf{0.7}$ and $\omega_n = \mathbf{10}$ **rad/sec.** Find resonant peak, resonant frequency and bandwidth. 6M

b. Sketch the polar plot for the open loop transfer function of a unity feedback system is given by **G(s)** = $\frac{1}{S(1+S)(1+2S)}$. Determine Gain Margin & Phase Margin. 6M

Q.7 A system is given by **G(s) H(s)** = $\frac{(4S+1)}{S^2(S+1)(2S+1)}$ Sketch the nyquist plot and determine the stability of the system. 12M

Q.8 Draw the Nyquist plot for the system whose open loop transfer function is, 12M

G(s)H(s) = $\frac{K}{S(S+2)(S+10)}$. Determine the range of K for which closed loop system is stable.

Q.9 Obtain the transfer function of Lead Compensator, draw pole-zero plot and write the procedure for design of Lead Compensator using Bode plot. 12M

Q.10 Obtain the transfer function of Lag Compensator, draw pole-zero plot and write the procedure for design of Lag Compensator using Bode plot. 12M

UNIT-V

STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS

Q.1 Determine the Solution for Homogeneous and Non homogeneous State equations 12M

Q.2 For the state equation: $\dot{X} = \begin{pmatrix} \mathbf{0} & \mathbf{1} \\ \mathbf{-2} & \mathbf{-3} \end{pmatrix}\mathbf{X} + \begin{pmatrix} \mathbf{0} \\ \mathbf{1} \end{pmatrix}\mathbf{U}$ with the unit step input and the initial conditions are $\mathbf{X(0)} = \begin{pmatrix} \mathbf{1} \\ \mathbf{1} \end{pmatrix}$ Find the following (a) State transition matrix (b) Solution of the state equation. 12M

Q.3 A system is characterized by the following state space equations:

$\dot{X}_1 = -3x_1 + x_2$; $\dot{X}_2 = -2x_1 + u$; $Y = x_1$

(a) Find the transfer function of the system and Stability of the system. 6M

(b) Compute the STM 6M

Q.4 a. State the properties of State Transition Matrix. 6M

b. Diagonalize the following system matrix $A = \begin{pmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{pmatrix}$ 6M

Q.5 a. Obtain state variable representation of an armature controlled D.C. Motor. 6M

b. A state model of a system is given as: 6M

$$\dot{X} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{pmatrix}X + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} U \text{ and } Y = (1 \;\; 0 \;\; 0)X$$

Determine: (i) The Eigen Values. (ii) The State Transition Matrix.

Q.6 a. Derive the expression for the transfer function and poles of the system from the state model. $\dot{X} = Ax + Bu$ and $y = Cx + Du$ 6M

b. Diagonalize the following system matrix $A = \begin{pmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{pmatrix}$ 6M

Q.7 Obtain a state model for the system whose Transfer function is given by 12M

$$\frac{Y(s)}{U(s)} = \frac{(7S^2+12S+8)}{(S^3+6S^2+11S+9)}$$

Q.8 a. State the properties of STM. 4M

8M

b. For the state equation: $\dot{X} = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix} \mathbf{X} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} \mathbf{U}$ when, $\mathbf{X(0)} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$.

Find the solution of the state equation for the unit step input.

Q.9

a. Find the state model of the differential equation is $\dddot{y} + 2\ddot{y} + 3\dot{y} + 4y = u$ 6M

b. Diagonalize the following system matrix $A = \begin{pmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{pmatrix}$ 6M

Q.10 a. Define state, state variable, state equation. 6M

b. Derive the expression for the transfer function from the state model. 6M

$\dot{X}$ = Ax + Bu and y = Cx + Du

Prepared by: **K.Mani & C.R. Hemavathi**

UNIT –I

CONTROL SYSTEMS CONCEPTS

1) In ________ controlsystems the control action is dependent on the desired output [ ]

A) Open loop B) Closed loop

C) Both (A) & (B) D) None

2) The Transfer function is the ratioof [ ]

A) L[O/P] to L[I/P] B) L[I/P] to L[O/P] with Zero initial conditions

C) L[I/P] to L[O/P] D) L[O/P] to L[I/P] with Zero initial conditions

3) For Impulse input, the output response C(s) is equal to. [ ]

A) R(s) B) E(s)

C) G(s) D) B(s)

4) The mass will offer an opposing force whichis proportional __ of thebody [ ]

A) Displacement B) Velocity

C) Acceleration D) None

5) The Dash-pot has displacement at both ends then the opposing force is proportional to [ ]

____ofthebody

A) Velocity B)Differential Velocity

C) Differential displacement D) None

6) Block diagrams can be used used to represent_______ [ ]

A) Linear systems B)Non-Linear systems

C) Both (A) & (B) D) None

7) Three blocks with gains **2,-5and10** are connected in parallel. The total gain is __ [ ]

A) -100 B) -07

C) 100 D) 07

8) __________ converts the angular position of the shaft into electrical signal [ ]

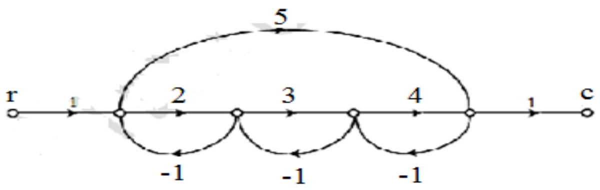
A) DCServomotor B) AC Servomotor

C) Tacho generator D) Synchro

9) The C.E of an armature controlled dc servomotor is__________ order equation [ ]

A) First B) Second

C) Third D) Zero

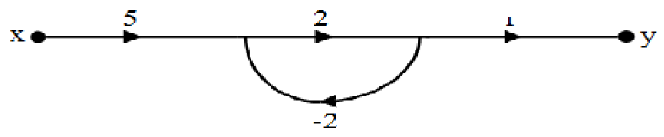


10) In the above signal flow graph of figure the gain c/r willbe [ ]

A)11/9 B) 24/23

C) 22/15 D) 44/23

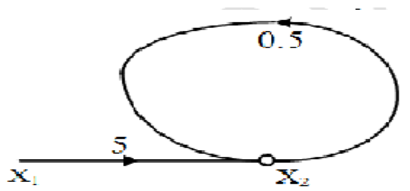
11) In the signal flow graph of figure y/x equal [ ]



A)3 B)2

C)5/2 D)NONE **GATE 1997**

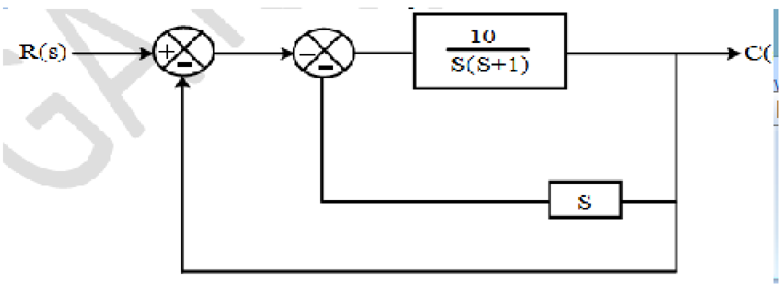
12) In the signal flow Graph shownin figure X_2=TX_1whereT,isequal [ ]



A)10 B)5

C)2.5 D)none **GATE 1987**

13.For the system shown in figure the transfer function is__________ [ ]



A)$10/s^2+s+10$ B)$10/s^2+11s+1$

C)$10/s^2+10$ D)$10/s^2+11s+10$ **GATE 1987**

14) In force-voltage analogy, Mass element is equal to ________ [ ]

A) Resistance B) Inductance

C) Capacitance D) Conductance

15) The spring will offer an opposing force which is proportional ___ of the body [ ]

A) Velocity B)Differential Velocity

C) Displacement D) Differential displacement

16) The dash-pot will offer an opposing force which is proportional ___ of the body [ ]

A) Velocity B) Differential Velocity

C) Differential displacement D) None

17) The viscous friction co-efficient, in force-voltage analogy, is analogous to [ ]

A) Charge B) resistance

C) reciprocal of inductance D) reciprocal of conductance

18) In force-voltage analogy, velocity is analogous to [ ]

A) Current B) charge

C) inductance D) capacitance

19) AC servomotor differs with normal induction motor in [ ]

A) Small X/R ratio B) large X/R ratio

C) linear speed-torque D) both A) and C)

20) A.C. servomotor is basically a _____________ motor [ ]

A) Universal B) single phase induction

C) two phase induction D) three phase induction

21) Synchro is basically a______ [ ]

A) 2-phase IM B) 3-phase IM

C) 3-phase alternator D) Transformer

22) For a second order undamped system, the poles are [ ]

A) Purely imaginary B) complex conjugate

C) real & equal D) real & unequal

23) AC servomotor differs with normal induction motor in [ ]

A) Small X/R ratio B) large X/R ratio

C) linear speed-torque D) both (A) and (C)

24) In force-current analogy, Mass element is equal to ______ [ ]

A) Resistance B) Inductance

C) Capacitance D) Conductance

25) The viscous friction co-efficient, in force-voltage analogy, is analogous to [ ]

A) Charge B) resistance

C) reciprocal of inductance D) reciprocal of conductance

26) In force-voltage analogy, displacement is analogous to [ ]

A) Current B) charge

C) inductance D) capacitance

27) In force-voltage analogy, Spring element is equal to ______ [ ]

A) Resistance B) Inductance

C) Capacitance D) Conductance

28) The spring has displacement at both ends then the opposing force is proportional to____ of Thebody [ ]

A) Velocity B)Differential Velocity

C) Differential displacement D)None

29) In force-voltage analogy, dashpot element is equal to ____ [ ]

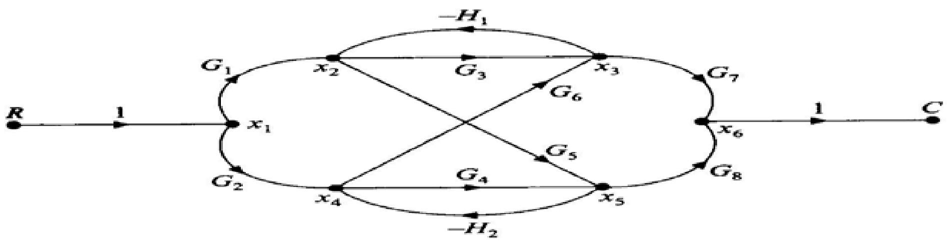
A) Resistance B) Inductance

C) Capacitance D) Conductance

30) Regenerative feedback implies feedback with [ ]

A) Oscillations B) step input

C) negativesign D) positive sign



31)In the above SFG the no of forward paths and individual loops are ____ [ ]

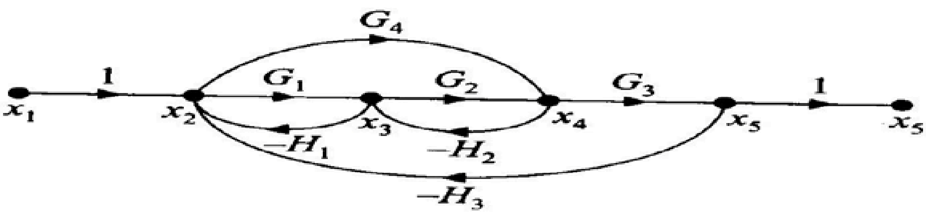
A)4,2 B) 4,3

C) 6,3 D) 6,2

32) In the above SFG the no of two non-touching and three non-touching loops are ____ [ ]

A) 1,0 B) 1,1

C) 2,1 D) 3,1



33) In the above SFG the no of forward paths and individual loops are _____ [ ]

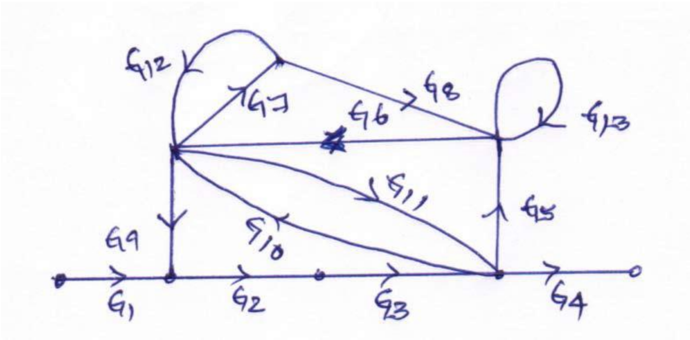
A)2,4 B) 3,2

C) 4,3 D) 2,5

34) In the above SFG the no of two non-touching and three non-touching loops are ____ [ ]

A) 0,0 B) 3,0

C) 3,1 D) 4,2



35) In the above SFG the no of forward paths and individual loops are _____ [ ]

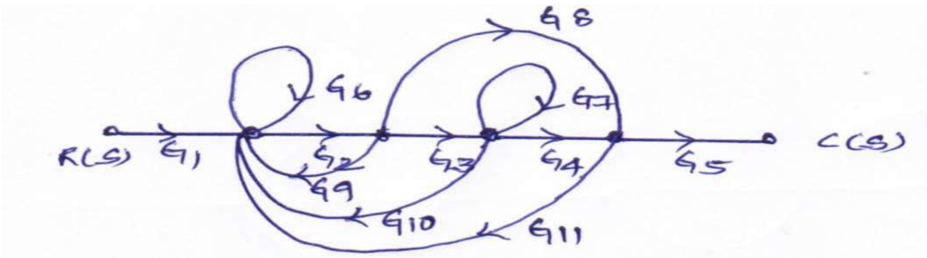
A)1,6 B) 1,7

C) 1,4 D) 1,5

36) In the above SFG the no of two non-touching and three non-touching loops are ____ [ ]

A) 2,0 B) 3,0

C) 3,1 D) 4,2



37) In the above SFG the no of forward paths and individual loops are ____ [ ]

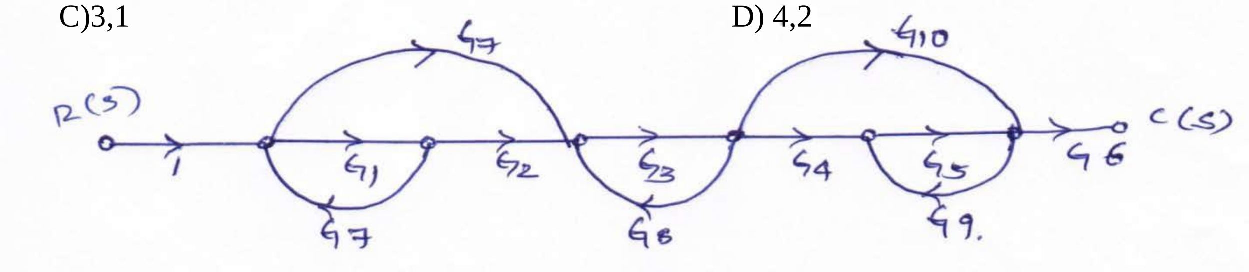
A)2, 5 B) 3, 5

C) 2, 6 D) 3, 6

38) In the above SFG the no of two non-touching and three non-touching loops are ____ [ ]

A) 2,0 B) 3,0

C)3,1 D) 4,2



39) In the above SFG the no of forward paths and individual loops are ___ [ ]

A)2,3 B) 2,4

C) 4,3 D) 3,5

40) In the above SFG the no of two non-touching and three non-touching loops are ____ [ ]

A) 2,0 B) 3,0

C) 3,1 D) 4,1

UNIT-II

TIME RESPONSE ANALYSIS

1) For Type-1 system the steady state error due to step input is equal to [ ]

A) Infinity B) Zero

C)One D) Constant

2) A system has the following T.F **G(s)** = $\frac{200(S+5)(S+50)}{S^4(S+10)(S^2+3S+10)}$

The order and type of the system are respectively [ ]

A) 4& 7 B) 4& 9

C) 7& 4` D) 9& 4

3) Which of the following systems is generally preferred [ ]

A) Undamped B) Under damped

C) Critically damped D) Over damped

4) The damping frequency of oscillation is given by [ ]

A) $W_d=W_r\sqrt{1-\xi^2}$ B) $W_d=W_r\sqrt{1+\xi^2}$

C) $W_d=W_n\sqrt{1-\xi^2}$ D) $W_d=W_n\sqrt{1+\xi^2}$

5) For a second order critically damped system, the poles are [ ]

A) Purely imaginary B) complex conjugate

C) real & equal D) real & unequal

6) The solution of the differential equation $x^2+2x+2=0$ is [ ]

A) Oscillatory B) over damped

C) under damped D) critically damped

7) Given a unity feedback system with G(s)=K/s(s+4), the value of K for damping ratio of 0.5 is

A)1 B)4 [ ]

C)16 D)64

8) Due to the derivative control, the rise time is [ ]

A)Reduced B) increased

C) not effected D) zero

9) The effect of addition of pole at origin, increases the system [ ]

A) Order B)Type

C) Order and type D) none

10) The type 2 system has ___________at the origin. [ ]

A) No net pole B) net pole

C) simple pole D) two poles

11) The position and velocity error constants of a type-2 system are [ ]

A) Constant, constant B) constant, infinity

C) zero, constant D) infinity, infinity

12) Velocity error constant of a system is measured when the input to the system is unit [ ]

A) Parabolic B) ramp

C) impulse D) step

13)In case of type-1 system steady state error for parabolic input is [ ]

A) Unity B) infinity

C) zero D)10

14) For a second order over damped system, the poles are [ ]

A) Purely imaginary B) complex conjugate

C) real & equal D) real & unequal

15) Position error constant of a system is measured when the input tothesystem is unit [ ]

A) Parabolic B) ramp

C) impulse D) step

16) For Type-1 system the steady state error due to step input is equal to [ ]

A) Infinity B) Zero

C)One D) Constant

17) The positional error of the open loop transfer function G(s)= **10/((s+2)(s+3))** with unity feedback system. [ ]

A) 0.075 B) 1

C) 0.375 D) 0.2

18) The value of ξ of 0.6 in the step input of a 2^{nd} order system results in max overshoot of [ ]

A)10 B) 8.54

C) 9.44 D) 7.55

19) Order of the given open loop transfer function G(s) = $\frac{K(s+2)}{s^2(s^2+2s+1)}$ [ ]

A) Zero B) one

C) two D) four

20) Consider a feedback control system with loop transfer function [ ]

$G(s)=\frac{K(1+0.5s)}{s(1+s)(1+2s)}$ The type of the closed loop system is

A) zero B) one

C) two D) three GATE 1998

21) The settling time of 2nd order system is ____ times the time constant of the system. [ ]

A) One B) Two

C) Four D) Six

22) For a second order under damped system, the poles are [ ]

A) Purely imaginary B) complex conjugate

C) real & equal D) real & unequal

23) The Laplace transform of impulse function is [ ]

A) zero B) one

C) infinity D) none

24) For the unity feedback control with G(s) =4/(S^2+8S+4), the damping ratio is [ ]

A)2 B)1

C) 0.707 D) 0.5

25) In time domain analysis response of the system varies w.r.t ___________ [ ]

A) Time B) frequency

C) both time and frequency D) constant

26) Undamped natural frequency for**S^2+2S+1=0**is [ ]

A) Zero B) one

C) two D) infinity

27) Order of the given open loop transfer function G(s) = K/(S+1) [ ]

A) Zero B) one

C) two D) three

28) The effect of addition of pole atorigin, increases the system [ ]

A)Order B)Type

C) Order and type D) none

29) The type 1 system has ___________at the origin. [ ]

A) No net pole B) net pole

C) simple pole D) two poles

30) Position error constant of a system is measured when the input to the system is unit __[ ]

A) Parabolic B) ramp

C) impulse D) step

31) The steady state error due to a ramp input for a type two system is [ ]

A)0 B) infinity

C)4 D)constant

32) For a 2^{nd} order system with CLTF $T(s) = 1/(S^2+0.1S+1)$, the settlingtime for 5% band is [ ]

A)6 B)2

C)3 D)4

33) The steady state error of a stable 'type 0' unity feedback system for a unitstep function is [ ]

A)0 B) $1/1+K_P$

C)∞ D) $1/K_P$ **GATE 1990**

34) A unity-feedback control system has the open-loop transfer function $G(s)=\frac{4(1+2s)}{s^2(s+2)}$ [ ]

if the input to the system is a unity ramp, the steady-state error will be

A) 0 B) 0.5

C) 2 D) Infinity **GATE 1991**

35) Type of the system given $G(s) = 2/S^2(2+S)$ is equal to [ ]

A) Zero B) one

C) two D) three

36) If the characteristic equation of a closed-loop system is $s^2+2s+2=0$, then the system is [ ]

A) Overdamped B) Critically damped

C) Under damped D) undamped **GATE 1998**

37) Consider a system with the T.F $G(s) = \frac{(s+6)}{(Ks^2+s+6)}$. Its ξ = 0.5 then the value of K is [ ]

A) 2/6 B) 3

C) 1/6 D) 6 **GATE 2002**

38) For a 2nd order system, damping ratio (ξ) is 0< ξ<1, then the roots of the C.E are [ ]

A) real but not equal B) real and equal

C) complex conjugates D) imaginary **GATE 1995**

39) A casual system having the transfer function $G(s) = \frac{1}{(s+2)}$ is excited with $10u(t)$.

The time at which the output reaches 99% of its steady state value is ` [ ]

A) 2.7 sec B) 2.5 sec

C) 2.3 sec D) 2.1 sec **GATE 2004**

40) Order of the given open loop transfer function $G(s) = \frac{(s+2)}{s(s^2+2s+1)}$ [ ]

A) Zero B) one C) two D) three

UNIT –III

STABILITY ANALYSIS IN CONTROL SYSTEMS

1) When a system is excited by an unbounded input and produces an unbounded output,

Then thesystem is_____ [ ]

A) Stable B) unstable

C) conditionally stable D) nothing can said about stability

2) If there is a root locus on real axis between pole and zero then there exist______ [ ]

A)Break-in point B) breakaway point

C)Both D) none

3) The OLTF of a unity feedback control system is $G(s)=K/(S+2)^2$ the CLTF will have poles at [ ]

A) -2,-2 B) -2,-1

C)-2 + j, -2 – j D) -2, 2

4) The necessary condition of the Routh Hurwitz stability is_______ [ ]

A) Elements in the first column of the routh array is positive

B) coefficients should be zero

C) both A and B

D) None

5) The open loop transfer function of a unity feedback control system is given by

$G(s) = \frac{5(S+1)}{S^2(S+2)}$. The stability characteristics of the open loop configuration. [ ]

A) stable B) unstable

C) conditionally stable D) marginally stable

6) If the OLTF of an unity feedback system is the ration of numerator polynomial of degree 'm'

And a denominator polynomial of degree 'n' then the integer n-m represent the number of [ ]

A) Break away points B) Unstablepoles

C) Root locus branches D) Asymptotes

7) The open loop transfer function of the system is given by $G(s)= \frac{K}{S(S+2)(S+4)}$.

Themaximum Value of K for which the unity feedback system will be stable. [ ]

A) 16 B) 32

C) 48 D)64

8) Adding pole results _______ gain margin [ ]

A) decrease B) increase

C) AorB D) none

9) The rootlocus is a [ ]

A) time domain approach B) frequency domain approach

C) combination of both D) None

10) The OLTF of a unity feedback system is given as G(s) = $\frac{K(S+2)}{S(S^2+2S+2)}$.

The angles of root locus Asymptotes are [ ]

A)$+90^0,-90^0$ B)$+60^0,-60^0$

C) $+120^0,-120^0$ D) $+360^0,-360^0$

11) The no.of. roots of the equation $\mathbf{2S^4+S^3+3S^2+5S+7=0}$ that lies in the right half of S-plane [ ]

A) 0 B) 1

C) 2 D) 3

12) Loop TF is K(S+1)(S+2))/((S+4)(S+6) for K=0 closed loop poles are at. [ ]

A) -1,-2 B) -4,-6

C) ∞, ∞ D) 0,0

13) The number of changes in first column of Routh array represents [ ]

A) Stability B) unstability

C) Number of roots lie on right sideof s-plane D) both b and c

14) The stability of the system can be increased by adding___ [ ]

A) Pole B) zero

C) both D) none

15) The root locus of system with G(s) H(s)=$\mathbf{K(S+1)/(S^2\,(S+3.6)}$ has how many asympotoes [ ]

A) one point B) two points

C) +j , -j D) three points

16) The roots of the characteristic equation lies on the left of S-plane, then system is [ ]

A) stable B) unstable

C) conditionally stable D) marginally stable

17) The characteristic equation of a system is given by $\mathbf{S^4+8S^3+12S^2+8S+K=0}$.for the system

To remain stable, the value of gain K should be [ ]

A) 0 B) 0 < K < 11

C) K > 11 D) Positive

18) The open loop transfer function of a unity feedback control system is given by [ ]

G(s)=**5(S+1)/S^2 (S+2).** The stability characteristics of the closedloopconfiguration.

A) Stable B) unstable

C) conditionally stable D) marginally stable

19) The characteristic equation of a feed back control system is **$2S^4+S^3+3S^2+5S+10=0$.**

The Numberof rootsin the right half ofS plane are [ ]

A) 0 B) 1

C) 2 D) 3

20) The root locus is [ ]

A) an algebraic method B) a graphical method

C) combination of both D) None

21) Break points can be [ ]

A) only real B) only complex

C) real or complex D) None

22) Asymptotes can intersect [ ]

A) only on the negativerealaxis B) only on the positive real axis

C) anywhere on the real axis D) imaginary axis

23) The open loop transfer function of a system is G(s)H(s)=**k/s(s+1)(s+2).**Its centroid is at s=

A) -2.5 B) -4 [ ]

C) -4.5 D) -1

24) If the roots of characteristic equation lie on imaginary axis the system is [ ]

A) Stable B) unstable

C) Conditionally stable D) marginally stable

25) If first entry in any row of Routh array is negative the system is [ ]

A) Stable B) unstable

C) Conditionally stable D) marginally stable

26) The number of changes in first column of Routh array represents [ ]

A) Stability B) unstability

C) Number of roots lie on right sideof s-plane D) both B and C

27) By adding the pole in the transfer function, The rootlocus shift towards [ ]

A) Right half of S plane B) left half of S plane

C) imaginary axis D) All

28) If the system output is finite for any finite input, then the system is______ [ ]

A) Stable B) unstable

C) conditionally stable D) nothing can said about stability

29) Root loci of a system has three asymptotes the systemmay have [ ]

A) 3 poles and 1 zero B) 4 poles and 2 zeros

C) 4 poles and 3 zeros D) 5 poles and 2 zeros

30) If the roots of the characteristic equation have negative real parts, then the system is [ ]

A) stable B) unstable

C) conditionally stable D) marginally stable

31) Loop TF isfor K=0 closed looppoles are at. [ ]

A) -1,-2 B) -4,-6

C) ∞ D) 0,0

32) If there is a root locus on real axis between two zeros then there exist______ [ ]

A) Break-in point B) breakaway point

C) Both D) none

33) The number of roots of $s^3 + 5s^2 + 7s + 3 = 0$ in the left half of the s – plane is [ ]

A) Zero B) One

C) Two D) Three **GATE 1998**

34) An amplifier with resistive negative feedback has two left half plane poles in its open – loop transfer function. The amplifier [ ]

A) Will always be unstable at high frequency

B) Will be stable for all frequency

C) May be unstable, depending on the feedback factor

D) Will oscillate at low frequency **GATE 2000**

35) The phase margin of a system with the open – loop transfer function $G(s)H(s)=\frac{(1-s)}{(s+1)(s+2)}$ [ ]

A) 0^0 B) 63.4^0

C) 90^0 D) ∞ **GATE 2002**

36) The open – loop transfer function of a unity – gain feedback control system is given by

$T(s)=\frac{K}{(s+1)(s+2)}$. The gain margin of the system in dB is given by [ ]

A) 0 B) 1

C) 20 D) ∞ **GATE 2006**

37) The gain margin for the system with open – loop transfer function $G(s)H(s) = 2(1+s)/s^2$ is [ ]

(A) ∞ (B) 0

(C) 1 (D) −∞ **GATE 2004**

38) If the closed – loop transfer function of a control system is given as $T(s) = \frac{(s-5)}{(s+2)(s+3)}$, then it is [ ]

(A) an unstable system (B) an uncontrollable system

(C) a minimum phase system (D) a non – minimum phase system **GATE 2007**

39) Consider a characteristic equation given by $\mathbf{3s^3 + 5s^2 + 6s + K + 10 = 0}$. The condition for stability is [ ]

(A) K > 5 (B) – 10 < K

(C) K > – 4 (D) – 10 < K < – 4 **GATE 1988**

40) An electromechanical closed-loop control system has the following characteristic equation; $\mathbf{s^3 + 6Ks^2 + (K + 2) + 8 = 0}$. Where K is the forward gain of the system. The condition for closed loop stability is: [ ]

A) K = 0.528 B)2

C) 3 D) none **GATE 1990**

UNIT-IV

FREQUENCY RESPONSE ANALYSIS

1) A system is unstable when [ ]

A)$\omega_{gc}=\omega_{pc}$ B)$\omega_{gc}<\omega_{pc}$

C)$\omega_{gc}>\omega_{pc}$ D)$\omega_{gc}=\omega_{pc}=0$

2) ξ= 0, Mr is given by [ ]

A)Infinity B)0

C)1 D)4

3)The slope of(1+jω)is [ ]

A) +20db B) +40db

C)-40db D)-20db

4) A unity feedback system $G(s)=(10(s+2))/(s^2 (s+1)(s^2+2s+2))$.The slope of the low frequency asymptote is [ ]

A) -20dB/dec B) -40dB/dec

C) -80dB/dec D) 80dB/dec

5) The damping frequency of oscillation is given by [ ]

A)$W_d=W_r\sqrt{1-\xi^2}$ B)$W_d=W_r\sqrt{1+\xi^2}$

C)$W_d=W_n\sqrt{1-\xi^2}$ D)$W_d=W_n\sqrt{1+\xi^2}$

6) The effect of addition of pole increases the system [ ]

A) Order B)Type

C) Order and type D) none

7) At the gain crossover frequency [ ]

A) G(jw)H(jw)=0dB B) G(jw)H(jw)= 1 dB

C) G(jw)H(jw)= -20 dB D) G(jw)H(jw)=20dB

8) The reciprocal of the magnitude of OLTF at phase cross over frequency is called [ ]

A) Phase margin B)gain margin

C) Phase plot D) Magnitude plot

9) Angle of G(jw) H(jw) =0at [ ]

A) gain cross over frequency B) Phase cross over frequency

C) Both D) none

10) From the bode plots it is observed that the gain cross over frequency is greater than phase cross overfrequency. The system is called_______ [ ]

A) Stable B)Marginally stable

C) Conditionally stable D) Unstable

11) From the bode plots it is observed that the gain cross over frequency is lesser than phase crossover frequency. The system is called_______ [ ]

A) Stable B)Marginally stable

C) Conditionally stable D) Unstable

12) For the pole factor $\frac{1}{(S+5)}$ the cornerfrequency is [ ]

A)1/5 B)5

C)-1/5 D)-5

13) At the phase crossover frequency w=10 rad / sec , G(jw)H(jw)=15 Db .It's gain margin is [ ]

A) 15 dB B) 0dB

C)-15dB D) cannot be predicted

14) The frequency at which the -3db magnitude is zero is called [ ]

A) Cut-offrate B) Cut-offResonant

C) Cut-off frequency D) Bandwidth

15)The slope of(1+jω) is [ ]

A) +20db B) +40db

C)-40db D)-20db

16) Magnitude of G(jw) H(jw) =1 at [ ]

A) gain cross over frequency B) Phase cross over frequency

C) Both D) none

17)1 DB= ___ [ ]

A) $20\log_e G(j\omega)$ B) G(j ω)
C) $20\log_{10} G(j\ \omega)$ D) $-20\log_{10} G(j\ \omega)$

18) Order of the given open loop transfer function G(s) = K**(S+2) / S^2 (S^2+2S+1)]** [ ]

A) Zero B) one

C) two D) four

19) Type of the system given in problem no. 18 is equal to [ ]

A) Zero B) one

C) two D) four

20) The settling time of II^{nd} order system is ____ times the time constant of the system. [ ]

A) One B)Two
C) Four D) Six

21) For a second order under damped system, the poles are [ ]

A) Purely imaginary B) complex conjugate

C) real & equal D) real & unequal

22) A system is unstable when [ ]

A)ωgc=ωpc B)ωgc<ωpc

C)ωgc>ωpc D)ωgc=ωpc=0

23) Gain cross over frequency is the one at whichG(jω)H(jω)is [ ]

A) equal to1 B) equal to-1

C) >1 D) <-1

24)The slope of1/(1+jω) is [ ]

A) +20db B) +40db

C) -40db D) -20db

25) The phase crossover frequencyis the frequency at which the phase ofG(jω) is [ ]

A) 0◦ B)90◦

C) 270◦ D) 180◦

26) The sinusoidal transfer function is obtained by replacing ‘s’ by__________ [ ]

A) jω B)$(j\omega)^2$

C) $(-j\omega)^2$ D)-jω

27) The effect of addition of pole increases the system [ ]

A) Order B)Type

C) Order and type D) none

28) A second order overall transfer functionis given by $4/(S^2+2S+4)$. Its resonant frequency is

A) 2 B) 1.414 [ ]

C) 1.732 D) 3

29) The system with the open loop transfer function $G(s)H(s) = 1/s(s^2+s+1)$ has a gain margin of [ ]

A) – 6 dB B) 0Db

C) 3.5Db D) 6 Db

30) A system has fourteen poles and two zeros. Its high frequency asymptote in its magnitude plot having a slope of: [ ]

(A) – 40 dB/decade (B) – 240 dB/decade

(C) – 280 dB/decade (D)–320dB/decade

31) The polar plot $G(s)=10/ (S+1)^3$of intercepts real axis at $\omega=\omega_0$. Then, the real partand ω_0 are respectivelygiven by: [ ]

(A) – 2.5, 1 (B)–5,0.5

(C)–5,1 (D) – 5, 2

32) From the Nicholas chart one can determine the following quantities pertaining to a closed loop system: [ ]

(A) Magnitude and phase (B) Band width

(C) Only magnitude (D) Only phase **GATE 1989**

33) The open-loop transfer function of a feedback control system is $G(s)=1/ (S+1)^3$. The gain margin of the system is [ ]

(A) 2 (B)4

(C) 8 (D) 16 **GATE 1991**

34) Non-minimum phase transfer function is defined as the transfer function [ ]

(A) which has zero in the right-half s-plane
(B) which has zero only in the left-half s-plane
(C) which has poles in the right-half s-plane
(D) which has polesin the left-half s-plane

35) The Nyquist plot of loop transfer function $G(s)H(s)$ of a closed loop control system passes through the point $(-1, j\,0)$ in the $G(s)H(s)$plane. The phase margin of the system is of the system is

A) 0^0 B) 45^0 [ ]

C) 90^0 D) 180^0 **GATE: 2004**

36) The Nyquist plot of G(S) H(S)for a closed loop control system, passed through (-1,j 0) Point in GH plane. The gain margin of the system in dB is equal to [ ]

(A) infinite (B) greater than zero

(C) less than zero (D) zero **GATE 2006**

37) In the Bode – plot of a unity feedback control system, the value of phase of G(jω) at the gain cross over frequency is – 125^0.The phase margin of the system is [ ]

(A) –125^0 (B) – 55^0

(C) 55^0 (D) 125^0 **GATE 1998**

38) In a Bode magnitude plot, which one of the following slopes would be exhibited athigh frequency by 4th order all-pole system? [ ]

A) – 80 dB/decade B) – 40 dB/decade

C) + 40 dB/decade D) + 80 dB/decade **GATE: 2014**

39) For the equation, $s^3 - 4s^2 + s + 6 = 0$ the number of roots in the left half ofs -plane will be[ ]

A) Zero B) One

C) Two D) Three **GATE: 2004**

40) The gain margin of a unity feed back control system with the OLTF$G(s)=s+1/s^2$ [ ]

A) 0 B) 1/√2

C) √ 2 D) 3 **GATE: 2005**

UNIT-V

STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS

1. $\emptyset(s)$ is called [ ]

A) system matrix B) state transition matrix

C) Resolvent Matrix D) Resolution Matrix

2. $\emptyset(t)$is called [ ]

A) system matrix B) state transition matrix

C) model matrix D) input matrix

3) The smallest set of variable of a state is called [ ]

A) State B)conditionofstate

C) Eigen values D) state variables

4) Solution of the state equation with conceding the input is called [ ]

A) Homogenous solution B) non homogeneous solution

C) both D) none

5) $X^{\cdot}(t) = AX(t) + BU(t)$ is called [ ]

A) state model B)stateequation

C) output equation D)all

6) Given a system represented by equations $X^{\cdot}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(t) + \begin{matrix} 0 \\ 1 \end{matrix} U(t)$ and

Y = $1 \quad 0$ X(t) The equivalent transfer function representation G(s) of the system is [ ]

A) $G(s)=1/s^2+5s+2$ B) $G(s)=1/s^2+3s+2$

C) $G(s)=3/s^2+5s+2$ D)none

7) Given a system represented by equations $X^{\cdot}(t) = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} X(t) + \begin{matrix} 1 \\ 1 \end{matrix} U(t)$

The state transition matrix of the system is [ ]

A) e^{2t} I B) e^{-2t} I

C) I D) none

8) Which among the following is a unique model of a system? [ ]

A) Transfer function B) State variable

C) Both a and b D) None of the above

9) According to the property of state transition method, e^0 is equalto ___ [ ]

A) I B) A

C) e^{-At} D) $-e^{At}$

10) Which mechanism in control engineering impliesan ability to measure the state by taking measurements at output? [ ]

A) Controllability B) Observability

C) Differentiability D) Adaptability

11) State model representation is possible using _________ [ ]

A) Physical variables B) Phase variables

C) Canonical state variables D) All of the above

12)Which among the following constitute the state model of a system in addition to state equations**?**

A) Input equations B) Output equations

C) State trajectory D) State vector [ ]

13)Which among the following plays a crucial role in determining the state of dynamic system?

A) State variables B) State vector

C) State space D) State scalar [ ]

14) Which among the following are the interconnected units of state diagram representation?

A) Scalars B) Adders

C) Integrators D) All of the above [ ]

15) State space analysis is applicable even if the initial conditions are [ ]

A) Zero B) Non-zero

C) Equal D) Not equal

16) Conventional control theory is applicable to ______ systems [ ]

A) SISO B) MIMO

C) Time varying D) Non-linear

17) The number of elements in the state vector is refered to _________ of the system [ ]

A) Order B) Characteristic Equation

C) Type D) all

18) In $X^{\cdot}(t) = AX(t) + BU(t)$A is known as [ ]

A) System Matrix B) InputMatrix

C) Output Matrix D) Transmission Matrix

19) In$X^{\cdot}(t) = AX(t) + BU(t)$**B** isknown as [ ]

A) System Matrix B) InputMatrix

C) Output Matrix D) Transmission Matrix

20) In $Y(t) = CX(t) + DU(t)$**C** isknown as [ ]

A) System Matrix B) InputMatrix

C) Output Matrix D) Transmission Matrix

21) In$Y(t) = CX(t) + DU(t)$**D** isknown as [ ]

A) System Matrix B) InputMatrix

C) Output Matrix D) Transmission Matrix

22)The state equations and the output equations together are called [ ]

A) state model B) stateequation

C) output equation D)Dynamic Equation

23) The characteristic equation of a state model is given by [ ]

A) |λI-A| =0 B) |λI+A| =0

C) |λI-A|=1 D) 0

24) The roots of the characteristic equation are referred to as _______of the matrix A. [ ]

A) state model B) eigen value

C) output equation D)all

25) The process of obtaining the state diagram of a system from its transfer function is [ ]

A) Diagonalization B) Phasevariable

C) Decomposition D) all

26) The matrix formed by placing the eigen vectors together in column-wise is called [ ]

A) System Matrix B) Modal Matrix

C) Transmission Matrix D) all

27) Which theorm states that every square matrix A satisfies its own characteristic equation.[ ]

A) Cayley-Hamilton B) Kalman's

C) Gilberts D) all

28) The concepts of controllability &observability were introduced by [ ]

A) Cayley-Hamilton B)Kalman's

C) Gilberts D) all

29) Controllability &observabilitycan also be determined by ____ method. [ ]

A) Cayley-Hamilton B) Kalman's

C) Gilberts D) all

30) The transfer function of a s/m can be obtained from its state model by using the [ ]

formula C(s)/R(s)=

A) $C(SI-A)^{-1}B+D$ B) C(SI-A)B+D

C) $C(SI-A)^{-1}$ D)all

31) State model is said to be stable if allits eigen values have [ ]

A) positivereal parts B) Negative real parts

C) Both D) None

32) A state variable system $X^{\cdot}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} X(t) + \begin{matrix} 1 \\ 0 \end{matrix} U(t)$ with the initial condition

$X(0) = [-1\ 3]^T$ and the unit step input u(t) has the state transition matrix [ ]

A) $\begin{bmatrix} 1 & 1/3(1-e-3t \\ 0 & e-3t \end{bmatrix}$ (B) $\begin{bmatrix} 1 & 1/3(e-t-e-3t \\ 0 & e-3t \end{bmatrix}$

C) $\begin{bmatrix} 1 & 1/3(e3-t-e-3t \\ 0 & e-3t \end{bmatrix}$ (D) $\begin{bmatrix} 1 & 1/3(1-e-3t \\ 0 & e-t \end{bmatrix}$ **GATE 2005**

33) The number of ways in which STM can be computed is [ ]

A) 2 B) 3 C) 5 D) 6

34) The state variable description of a linear autonomous system is, $\boldsymbol{X}^{o} = A\boldsymbol{X}$ where $\boldsymbol{X}$ is the two

dimensional state vector and A=$\begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$. The roots of the characteristic equation are [ ]

A) −2 and +2 B) −*j*2 and +*j*2

C) −2 and −2   D) +2 and +2   **GATE 2004**

35) The state transition matrix for the system $\boldsymbol{X}^o = A\boldsymbol{X}$ with initial state $\boldsymbol{X}(0)$ is [ ]

A) $(sI - A)^{-1}$ B) $e^{At}\boldsymbol{X}(0)$

C) $L^{-1}[(sI - A)^{-1}]$ D) $L^{-1}[(sI - A)^{-1}\boldsymbol{X}(0)]$ **GATE 2002**

36) For the system, $X^{\cdot}(t) = \begin{bmatrix} 2 & 3 \\ 0 & 5 \end{bmatrix} X(t) + \begin{matrix} 1 \\ 0 \end{matrix} U(t)$ which of the following statements is true [ ]

A) The system is controllable but unstable

B) The system is uncontrollable and unstable

C) The system is controllable and stable

D) The system is uncontrollable and stable   **GATE 2002**

37) The transfer function of the system describedby d^2y/dt^2+dy/dt=du/dt+2u

with *u*asinput and *y*asoutputis [ ]

A) $s+2/s^2+s$ B) $s+1/s^2+s$

C) $2/s^2+s$ D)$2s/s^2+s$

38) Given a system represented by equations $X^{\cdot}(t) = \begin{bmatrix} 2 & 0 \\ 0 & 4 \end{bmatrix} X(t) + \begin{matrix} 1 \\ 1 \end{matrix} U(t)$ with *u* as unit impulse

and with zero initial state, the output *y* , becomes [ ]

A) $2e^{2t}$ B) $4e^{2t}$

C) $2e^{4t}$ D) $4e^{4t}$ **GATE 2002**

39) Given a system represented by equations $X^{\cdot}(t) = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix} X(t) + \begin{matrix} 0 \\ 1 \end{matrix} U(t)$ [ ]

A) Stable and controllable   B) Stable but uncontrollable

C) Unstable but controllable   D) Unstable and uncontrollable **GATE 2010**

40) A function $y(t)$ satisfies the following differential equation : dy(t)/dt+y(t)= $\delta(t)$ where $\delta(t)$ is the delta function. Assuming zero initial condition, and denoting the unit step function by $u(t)$, $y(t)$ can be of the form [ ]

A) e^t B) e^{-t}

C) $e^t u(t)$ D) $e^{-t}u(t)$ **GATE 2008**

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