UNIT-I SYSTEMS AND THEIR REPRESENTATION

1. What is control system?

A system consists of a number of components connected together to perform a specific function . In a system when the output quantity is controlled by varying the input quantity then the system is called control system.

2. Define open loop control system.

The control system in which the output quantity has no effect upon the input quantity is called open loop control system. This means that the output is not feedback to the input for correction.

3. Define closed loop control system.

The control system in which the output has an effect upon the input quantity so as to maintain the desired output values are called closed loop control system.

4. What are the components of feedback control system?

The components of feedback control system are plant, feedback path elements, error detector actuator and controller.

5. Distinguish between open loop and closed loop system

S.No	Open Loop	Closed Loop
1	Inaccurate	Accurate
2	Simple and Economical	Complex and Costlier
3	The change in output due to external disturbance are not corrected	The change in output due to external disturbance are corrected automatically
4	May oscillate and become un stable	They are generally stable

6. Define transfer function.

The Transfer function of a system is defined as the ratio of the laplace transform of output to Laplace transform of input with zero initial conditions.

7. What are the basic elements used for modeling mechanical translational system.

Mass M, Kg, Stiffness of spring K, N/m and Viscous friction coefficient dashpot B, N-sec/m

8. What are the basic elements used for modeling mechanical rotational system?

Moment of inertia J, Kg-m 2/rad

dashpot with rotational frictional coefficient B, N-m/(rad/sec) And torsional spring with stiffness K ,N-m /rad.

9. Name two types of electrical analogous for mechanical system.

The two types of analogies for the mechanical system are Force voltage and Force current analogy

10. What is block diagram?

A block diagram of a system is a pictorial representation of the functions performed by each component of the system and shows the flow of signals**.**

11. What are the basic components of Block diagram?

The basic elements of block diagram are blocks, branch point and summing point.

12. What is the basis for framing the rules of block diagram reduction technique?

The rules for block diagram reduction technique are framed such that any modification made on the diagram does not alter the input output relation.

13. What is a signal flow graph?

A signal flow graph is a diagram that represents a set of simultaneous algebraic equations .By taking Laplace Transform the time domain differential equations governing a control system can be transferred to a set of algebraic equations in s-domain.

14. What is transmittance?

The transmittance is the gain acquired by the signal when it travels from one node to another node in signal flow graph.

15. What is sink and source?

Source is the input node in the signal flow graph and it has only outgoing branches. Sink is a output node in the signal flow graph and it has only incoming branches.

16. Define non touching loop.

The loops are said to be non touching if they do not have common nodes.

17. Write Masons Gain formula.

Mason‘s gain formula states that the overall gain of the system as follows Overall gain,

T = T(S) = transfer function of the system

K= Number of forward path in the signal flow.

PK = forward path gain of the Kth forward path

Δ = 1 –(Sum of individual loop gains) + (Sum of gain products of all possible combinations of two non touching loops) -(Sum of gain products of all possible combinations of three non touching loops) + ...

Δk = (Δ for that part of the graph which is not touching Kth forward path)

UNIT- II TIME RESPONSE

1. What is an order of a system?

The order of a system is the order of the differential equation governing the system. The order of the system can be obtained from the transfer function of the given system.

2. What is step signal?

The step signal is a signal whose value changes from zero to A at t= 0 and remains constant at A for t>0.

3. What is ramp signal?

The ramp signal is a signal whose value increases linearly with time from an initial value of zero at t=0.the ramp signal resembles a constant velocity.

4. What is a parabolic signal?

The parabolic signal is a signal whose value varies as a square of time from an initial value of zero at t=0.This parabolic signal represents constant acceleration input to the signal.

5. What is transient response?

The transient response is the response of the system when the system changes from one state to another.

6. What is steady state response?

The steady state response is the response of the system when it approaches infinity.

7. Define Damping ratio.

Damping ratio is defined as the ratio of actual damping to critical Damping.

8. List the time domain specifications.

The time domain specifications are

i. Delay time

ii. Rise time

iii. Peak time

iv. Peak overshoot

9. What is damped frequency of oscillation?

In under damped system the response is damped oscillatory. The frequency of damped oscillation is given by $\omega d = \omega n \sqrt{(1- \zeta}$

10. What will be the nature of response of second order system with different types of damping?

For undamped system the response is oscillatory.

For under damped system the response is damped oscillatory.

For critically damped system the response is exponentially rising.

For over damped system the response is exponentially rising but the rise time will be very large.

11. Define Delay time.

The time taken for response to reach 50% of final value for the very first time is delay time.

12. Define Rise time.

The time taken for response to raise from 0% to 100% for the very first time is rise time.

13. Define peak time

The time taken for the response to reach the peak value for the first time is peak time.

14. Define peak overshoot.

Peak overshoot is defined as the ratio of maximum peak value measured from the

Maximum value to final value

15. Define Settling time.

Settling time is defined as the time taken by the response to reach and stay within

specified error

16. What is the need for a controller?

The controller is provided to modify the error signal for better control action.

17. What are the different types of controllers?

The different types of the controller are

Proportional controller

PI controller

PD controller

PID controller

UNIT- III FREQUENCY RESPONSE

1. What is frequency response?

A frequency response is the steady state response of a system when the input to the system is a sinusoidal signal.

2. List out the different frequency domain specifications?

The frequency domain specifications are

Resonant peak.

Resonant frequency.

Bandwidth

Cut-off rate

Gain margin

Phase margin

3. Define –resonant Peak

The maximum value of the magnitude of closed loop transfer function is called resonant

peak.

4. What is bandwidth?

The bandwidth is the range of frequencies for which the system gain Is more than 3 dB.

The bandwidth is a measure of the ability of a feedback system to reproduce the input signal ,noise rejection characteristics and rise time.

5. Define Cut-off rate?

The slope of the log-magnitude curve near the cut-off is called cut-off rate. The cut-off rate indicates the ability to distinguish the signal from noise.

6. Define –Gain Margin?

The gain margin, kg is defined as the reciprocal of the magnitude of the open loop transfer function at phase cross over G(jω frequency. Gain margin kg = 1 /|pc)| .

7. Define Phase cross over?

The frequency at which, the phase of open loop transfer functions is 180° is called phase cross over frequency ωpc.

8. What is phase margin?

It is the amount of phase lag at the gain cross The phase margin ,γ over frequency required to bring system to the verge of instability.

9. Define Gain cross over?

The gain cross over frequency ωgc is the frequency at which the magnitude of the open loop transfer function is unity..

10. What is Bode plot?

The Bode plot is the frequency response plot of the transfer function of a system. A Bode plot consists of two graphs. One is the plot of magnitude of sinusoidal transfer function versus log ω.The other is a plot of the phase angle of a sinusoidal function versus log ω.

11. What are the main advantages of Bode plot?

The main advantages are:

i) Multiplication of magnitude can be in to addition.

ii) A simple method for sketching an approximate log curve is available.

iii) It is based on asymptotic approximation. Such approximation is sufficient if rough information on the frequency response characteristic is needed.

is available. iv) The phase angle curves can be easily drawn if a template for the phase angle curve of 1+ jω

12. Define Corner frequency?

The frequency at which the two asymptotic meet in a magnitude plot is called corner frequency.

13. Define Phase lag and phase lead?

A negative phase angle is called phase lag. A positive phase angle is called phase lead.

14. What are M circles?

The magnitude M of closed loop transfer function with unity feedback will be in the form of circle in complex plane for each constant value of M. The family of these circles are called M circles.

15. What is Nichols chart?

The chart consisting if M & N loci in the log magnitude versus phase diagram is called Nichols chart.

16. What are the uses of lead compensator?

The uses of lead compensator are

- speeds up the transient response
- increases the margin of stability of a system
- increases the system error constant to a limited extent.

17. What is the use of lag compensator?

The lag compensator Improve the steady state behavior of a system, while nearly preserving its transient response.

18. When lag-lead compensator is is required?

The lag lead compensator is required when both the transient and steady state response of a system has to be improved

19. What is a compensator?

A device inserted into the system for the purpose of satisfying the specifications is called as a compensator.

20. When lag/lead/lag-lead compensation is employed?

Lag compensation is employed for a stable system for improvement in steady state performance. Lead compensation is employed for stable/unstable system for improvement in transient state performance.

Lag-Lead compensation is employed for stable/unstable system for improvement in both steady state and transient state performance

21. What are the effects of adding a zero to a system?

Adding a zero to a system results in pronounced early peak to system response thereby the peak overshoot increases appreciably.

UNIT – IV STABILITY AND COMPENSATOR DESIGN

1. Define stability.

A linear relaxed system is said to have BIBIO stability if every bounded input results in a bounded output.

2. What is nyquist contour

The contour that encloses entire right half of S plane is called nyquist contour.

3. State Nyquist stability criterion.

If the Nyquist plot of the open loop transfer function G(s) corresponding to the nyquist contour in the S-plane encircles the critical point –1+j0 in the contour in clockwise direction as many times as the number of right half S-plane poles of G(s),the closed loop system is stable.

4. Define Relative stability

Relative stability is the degree of closeness of the system; it is an indication of strength or degree of stability.

5. What will be the nature of impulse response when the roots of characteristic equation are lying on imaginary axis?

If the root of characteristic equation lies on imaginary axis the nature of impulse response is oscillatory.

6. What is the relationship between Stability and coefficient of characteristic polynomial?

If the coefficient of characteristic polynomial are negative or zero, then some of the roots lie on the negative half of the S-plane. Hence the system is unstable. If the coefficients of the characteristic polynomial are positive and if no coefficient is zero then there is a possibility of the system to be stable provided all the roots are lying on the left half of the S-plane.

7. What is Routh stability criterion?

Routh criterion states that the necessary and sufficient condition for stability is that all of the elements in the first column of the routh array is positive. If this condition is not met, the system is unstable and the number of sign changes in the elements of the first column of routh array corresponds to the number of roots of characteristic equation in the right half of the S-plane.

8. What is limitedly stable system?

For a bounded input signal if the output has constant amplitude oscillations, then the system may be stable or unstable under some limited constraints such a system is called limitedly

stable system.

9. What is characteristic equation?

The denominator polynomial of C(S)/R(S) is the characteristic equation of the system. If the root of characteristic equation has positive real part then the impulse response of the system is not bounded. Hence the system will be unstable. If the root has negative real parts then the impulse response is bounded. Hence the system will be stable.

10. What is the necessary condition for stability?

The necessary condition for stability is that all the coefficients of the characteristic polynomial be positive. The necessary and sufficient condition for stability is that all of the elements in the first column of the routh array should be positive.

11. What are the requirements for BIBO Stability?

The requirement of the BIBO stability is that the absolute integral of the impulse response of the system should take only the finite value.

12. What is auxiliary polynomial?

In the construction of routh array a row of all zero indicates the existence of an even polynomial as a factor of given characteristic equation. In an even polynomial the exponents of S are even integers or zero only. This even polynomial factor is called auxiliary polynomial. The coefficients of auxiliary polynomial are given by the elements of the row just above the row of all zeros.

UNIT – V STATE VARIABLE ANALYSIS

1. Define state variable.

The state of a dynamical system is a minimal set of variables(known as state variables) such that the knowledge of these variables at t-t0 together with the knowledge of the inputs for t > t0 , completely determines the behavior of the system for t > t0

2. Write the general form of state variable matrix.

The most general state-space representation of a linear system with m inputs, p outputs and n state variables is written in the following form:

$\dot{X} = AX + BU$

$Y = CX + DU$

Where = state vector of order n X 1.

U = input vector of order n X1.

A=System matrix of order n X n.

B=Input matrix of order n X m

C =output matrix of order p X n

D = transmission matrix of order p X m

3. What is the necessary condition to be satisfied for design using state feedback?

The state feedback design requires arbitrary pole placements to achieve the desire performance. The necessary and sufficient condition to be satisfied for arbitrary pole placement is that the system is completely state controllable.

4. What is controllability?

A system is said to be completely state controllable if it is possible to transfer the system state from any initial state X(t0) at any other desired state X(t), in specified finite time by a control vector U(t).

5. What is observability?

A system is said to be completely observable if every state X(t) can be completely identified by measurements of the output Y(t) over a finite time interval.

6. Write the properties of state transition matrix.

1. $\Phi(0) = e^{Ax0} = I$ (unit matrix).
2. $\Phi(t) = e^{At} = (e^{-At})^{-1} = [\Phi(-t)]^{-1}$.
3. $\Phi(t_1+t_2) = e^{A(t1+t2)} = \Phi(t_1)\,\Phi(t_2) = \Phi(t_2)\,\Phi(t_1)$.

7. What is the need for controllability test?

The controllability test is necessary to find the usefulness of a state variable. If the state variables are controllable then by controlling (i.e. varying) the state variables the desired outputs of the system are achieved.

8. What is the need for observability test?

The observability test is necessary to find whether the state variables are measurable or not. If the state variables are measurable then the state of the system can be determined by practical measurements of the state variables.

9. How control system design is carried in state space?

In state space design of control system, any inner parameter or variable of a system are used for feedback to achieve the desired performance of the system. The performance of the system is related to the location of closed loop poles. Hence in state space design the closed loop poles are placed at the desired location

10. State the duality between controllability and observability.

The concept of controllability and observability are dual concepts and it is proposed by kalman as principle of duality.The principle of duality states that a system is completely state controllable if and only if its dual system is completely state controllable if and only if its dual system is completely observable or viceversa.