# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## ELECTRONICS AND COMMUNICATION ENGINEERING

### DEFINITIONS AND TERMINOLOGY

| | | |
|---|---|---|
| **Course Name** | : | **CONTROL SYSTEMS** |
| **Course Code** | : | **AEE009** |
| **Program** | : | **B.Tech** |
| **Semester** | : | **IV** |
| **Branch** | : | **Electronics and Communication Engineering** |
| **Section** | : | **A,B,C,D** |
| **Academic Year** | : | **2018– 2019** |
| **Course Faculty** | : | **Dr. K Nehru, Professor, ECE**<br>**Mr. N Nagaraju, Assistant Professor, ECE** |

### OBJECTIVES

| | |
|---|---|
| I | To help students to consider in depth the terminology and nomenclature used in the syllabus. |
| II | To focus on the meaning of new words / terminology/nomenclature |

**DEFINITIONS AND TERMINOLOGYQUESTION BANK**

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| UNIT - I | | | | | |
| 1 | What are the examples of system? | Motor (Input - Electrical energy, output – Mechanical Energy)<br>Air conditioner (Input - Electrical energy, output – Heat Energy) | Remember | 1 | CAEE009.01 |
| 2 | What are the classification of systems? | Linear and non-linear systems<br>Time variant and invariant systems<br>Static and dynamic systems<br>Causal and Non causal systems | Remember | 1 | CAEE009.01 |
| 3 | What is non-linear system? | The output of the system does not vary linearly with input. Example: Diode | Remember | 1 | CAEE009.01 |
| 4 | What is static system? | An unwanted input signal that affects the output signal. | Remember | 1 | CAEE009.01 |
| 4 | What is dynamic system? | The output of the system depends on present as well as past inputs. Example: Inductor. | Remember | 1 | CAEE009.01 |
| 5 | What is disturbance in control system? | The disturbance is the unwanted signal which affects the output of the system. Example: People entering and leaving AC room disturbs room temperature. | Remember | 1 | CAEE009.01 |
| 6 | What is a model of control system? | It is an elemental or mathematical representation of a plant or system. It helps in the analysis of input and output of the system. | Remember | 1 | CAEE009.01 |
| 7 | What are the different types of mathematical models in control system? | Differential equation model<br>Transfer function model<br>State space model | Remember | 1 | CAEE009.01 |
| 8 | What are the different types of physical systems? | Electrical systems<br>Mechanical systems<br>Electronic systems<br>Hydraulic systems<br>Thermal systems | Remember | 1 | CAEE009.01 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 9 | What are the different types of electrical systems? | Voltage source system<br>Current source system | Remember | 1 | CAEE009.01 |
| 10 | What are the electrical system elements in control systems? | Resistor: It is an element which resists the flow of current in an electrical system.<br>Capacitor: It is an element that stores electrical energy in a electric field.<br>Inductor: It is an element that stores electrical energy in a magnetic field. | Remember | 1 | CAEE009.01 |
| 12 | What are the different ways to analyze electrical systems? | Nodal analysis based on Kirchhoff's current law.<br>Loop or mesh analysis based on Kirchhoff's voltage law. | Remember | 1 | CAEE009.01 |
| 13 | What are the types of mechanical system based on type of motion? | The translational system is having linear motion.<br>The rotational system is having angular motion. | Remember | 2 | CAEE009.02 |
| 14 | What is on off control? | The On-Off control is the simplest form of feedback control. An on-off controller simply drives the manipulated variable from fully closed to fully open depending on the position of the controlled variable relative to the set point. Example: Switch. | Remember | 3 | CAEE009.03 |
| 15 | What is manipulated variable in system? | The control signal or manipulated variable is the quantity or condition that is varied by the controller so as to affect the value of the controlled variable. | Remember | 3 | CAEE009.03 |
| 16 | Define a system. | A system is a combination of components that act together to perform a specific goal. | Understand | CLO 1 | CAEE009.01 |
| 17 | Define reference input. | It is the actual signal input to the control system. | Understand | CLO 1 | CAEE009.01 |
| 18 | Define controlled variable (output). | The quantity that must be maintained at prescribed value. | Understand | CLO 1 | CAEE009.01 |
| 19 | Define disturbance. | An unwanted input signal that affects the output signal. | Understand | CLO 1 | CAEE009.01 |
| 20 | Describe open-loop control system. | A system in which the output has no effect on the input action. In other words, the output is neither measured nor fed back for comparison with the input. One practical example is a washing machine. | Understand | CLO 1 | CAEE009.01 |
| 21 | Define closed-loop control system. | A system in which the output has an effect on the input quantity in a way that can maintain the desired output value. An example is a room temperature control system. | Understand | CLO 1 | CAEE009.01 |
| 22 | Define control unit (dynamic element). | The unit that reacts to an actuating signal to produce a desired output. This unit does the work of controlling the output and thus may be a power amplifier. | Understand | CLO 1 | CAEE009.01 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 23 | Define feedback control system. | The unit that provides the means for feeding back the output quantity, or a function of the output, in order to compare it with the reference input. | Understand | CLO 1 | CAEE009.01 |
| 24 | Define an actuating signal. | The signal that is difference between the reference input and the feedback signal if actuates the control unit in order to maintain the output of the desired value. | Understand | CLO 1 | CAEE009.01 |
| 25 | Define the sensor or measuring element. | It is a device that converts the output variable into another suitable variable, such as a displacement, pressure, voltage, etc. | Understand | CLO 1 | CAEE009.01 |
| 26 | Define the actuator. | It is a power device that produces the input to the plant according to the control signal so that the output signal will approach the reference input signal. | Understand | CLO 1 | CAEE009.01 |
| 27 | Define automatic controllers. | An automatic controller compares the actual value of the plant output with the reference input (desired value), determines the deviation, and produces a control signal that will reduce the deviation to zero or to a small value. | Understand | CLO 1 | CAEE009.01 |
| 28 | Define transfer function. | The function of a linear time invariant differential equation system is defined as the ratio of Laplace transform of the output( response function) to the Laplace transform of the input(drive function) under the assumption that all initial conditions are zero. | Understand | CLO 2 | CAEE009.02 |
| 29 | Define servomotor. | The motors used in automatic control systems or in servomechanism are called servomotors. They are used to convert electrical signal into angular motion. | Understand | CLO 3 | CAEE009.03 |
| 30 | Define synchro. | A Synchro is a device used to convert an angular motion to an electrical signal or vice versa. | Understand | CLO 3 | CAEE009.03 |
| | | UNIT – II | | | |
| 1 | What are the components of block diagram? | The components of block diagram are summing point, branch point and block. | Remember | 4 | CAEE009.04 |
| 2 | What is block diagram reduction technique? | The block diagram reduction refers to simplification of block diagrams of complex systems through certain rearrangements. The simplification is done using certain rules called the ‘rules of block diagram algebra. | Remember | 4 | CAEE009.04 |
| 3 | What are the rules of block diagram of algebra? | Combining blocks in cascade<br>Combining blocks in parallel<br>Eliminating negative and positive feedbacks | Remember | 4 | CAEE009.04 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| | | Interchanging, splitting and combining summing points<br>Moving the summing point before and after the block | | | |
| 4 | What are the properties of signal flow graph? | The signal flow graph is obtained from block diagram and system equations. The equation must be in S domain and it is applicable only for linear systems. | Remember | 4 | CAEE009.04 |
| 5 | What are the components of signal flow graph? | The components of signal flow graph are node and branch. | Remember | 5 | CAEE009.05 |
| 6 | What is input node in signal flow graph? | The node is having only outgoing branches. | Remember | 5 | CAEE009.05 |
| 7 | What is output node in signal flow graph? | The node is having only incoming branches. | Remember | 5 | CAEE009.05 |
| 8 | What is path in signal flow graph? | It is the traversal of connected branches in the direction of branch arrows such that no node is traversed more than once. | Remember | 5 | CAEE009.05 |
| 9 | What is forward path in signal flow graph? | It is the path from input node to the output node. | Remember | 5 | CAEE009.05 |
| 10 | What is loop in signal flow graph? | It is the path which originates and terminates at the same node. | Remember | 3 | CAEE009.03 |
| 11 | What is path gain? | The product of branch gains in traversing a path. | Remember | 6 | CAEE009.06 |
| 12 | What are the different ways to analyzing time response systems? | 1. Natural response and forced response. 2. Transient response and steady state response. | Remember | 6 | CAEE009.06 |
| 13 | What is the standard test signals used in control system? | The standard test signals are unit impulse, unit step, unit ramp, unit parabolic and sinusoidal signals. | Remember | 6 | CAEE009.06 |
| 14 | What is type 0 system and position error constant? | Systems having a finite nonzero steady state error with a zero order polynomial input (step input) are called Type-0 systems. The position error constant for a system is defined for a step input. | Remember | 6 | CAEE009.06 |
| 15 | What is type 2 system and acceleration error constant? | Systems having a finite nonzero steady state error with a second order polynomial input (parabolic input) are called Type-2 systems. The acceleration error constant for a system is defined for a parabolic input. | Remember | 6 | CAEE009.06 |
| 16 | Describe block diagram. | A block diagram of a system is a pictorial representation of the functions performed by each component and of the flow of signals. | Understand | CLO 4 | CAEE009.04 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 17 | Define summing point. | A circle with a cross is the symbol that indicates a summing operation. The plus or minus sign at each arrowhead indicates whether that signal is to be added or subtracted. | Understand | CLO 4 | CAEE009.04 |
| 18 | Define branch point. | A branch point is a point from which the signal from a block goes concurrently to other blocks or summing points. | Understand | CLO 4 | CAEE009.04 |
| 19 | Define open loop transfer function. | The ratio of the feedback signal B(s) to the actuating error signal E(s) is called the open-loop transfer function. | Understand | CLO 4 | CAEE009.04 |
| 20 | Define signal flow graph. | A signal flow graph is a diagram that represents a set of simultaneous algebraic equations .By taking L.T the time domain differential equations governing a control system can be transferred to a set of algebraic equations in s-domain. | Understand | CLO 5 | CAEE009.05 |
| 21 | Define transmittance. | The transmittance is the gain acquired by the signal when it travels from one node to another node in signal flow graph. | Understand | CLO 5 | CAEE009.05 |
| 22 | Define 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. | Understand | CLO 5 | CAEE009.05 |
| 23 | Define non touching loop. | The loops are said to be non touching if they do not have common nodes. | Understand | CLO 5 | CAEE009.05 |
| 24 | Write Masons Gain formula. | Masons Gain formula states that the overall gain of the system is T = 1/ $\Delta$k Pk. k-No.of forward paths in the signal flow graph. Pk- Forward path gain of kth forward path $\Delta$k =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]+… k - for that part of the graph which is not touching kth forward path. | Understand | CLO 5 | CAEE009.05 |
| 25 | Define servomechanism. | The servomechanism is a feedback control system in which the output is mechanical position (or time derivatives of position velocity and acceleration). | Understand | CLO 3 | CAEE009.03 |
| 26 | Define transient response. | The transient response is the response of the system when the system changes from one state to another. | Understand | CLO 6 | CAEE009.06 |
| 27 | Define steady state response. | The steady state response is the response of the system when it approaches infinity. | Understand | CLO 6 | CAEE009.06 |
| 28 | Define 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 | Understand | CLO 6 | CAEE009.06 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 29 | Define damping ratio. | Damping ratio is defined as the ratio of actual damping to critical damping. | Understand | CLO 6 | CAEE009.06 |
| 30 | Define delay time. | The time taken for response to reach 50% of final value for the very first time is delay time. | Understand | CLO 6 | CAEE009.06 |
| UNIT – III | | | | | |
| 1 | What is stable system? | An LTI system is stable if and only if its natural response approaches zero as time $\rightarrow \infty$. | Remember | 7 | CAEE009.07 |
| 2 | What is unstable system? | An LTI system is unstable if and only if its natural response grows without bound as time $\rightarrow \infty$. | Remember | 7 | CAEE009.07 |
| 3 | What is marginally stable system? | An LTI system is marginally stable if and only if its natural response neither grows nor approaches zero as time $\rightarrow \infty$ | Remember | 7 | CAEE009.07 |
| 4 | What is natural response of system? | The natural response of a system is the response which is not due to any input, but only that which is due to initial conditions. | Remember | 8 | CAEE009.08 |
| 5 | What is un stable system based on pole location? | The poles are lying on right half of s plane then the system is called unstable system. | Remember | 8 | CAEE009.08 |
| 6 | What is stable system based on pole location? | The poles are lying on left half of s plane then the system is called stable system. | Remember | 8 | CAEE009.08 |
| 7 | What is marginally stable system based on pole location? | The poles are lying on imaginary axis of s plane then the system is called marginally stable system. | Remember | 7 | CAEE009.07 |
| 8 | What is Hurwitz stability test? | The Hurwitz stability test is most useful for testing the stability of large order stability systems. | Remember | 8 | CAEE009.08 |
| 9 | What is necessary condition for stability? | The characteristic equations having all the coefficients are positive. | Remember | 8 | CAEE009.08 |
| 10 | What is controller? | A controller is a device introduced in the system to modify the error signal and to produce a control signal. | Remember | 9 | CAEE009.09 |
| 12 | What is necessary condition for un stable? | The characteristic equations having negative or zero coefficients then the system is unstable system. | Remember | 9 | CAEE009.08 |
| 13 | What is relative stability? | The relative stability indicates the closeness of the system to stable region. It is an indication of the strength or degree of stability. | Remember | 9 | CAEE009.08 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 14 | What is the importance of root locus? | The root location can be plotted in the s plane by varying system parameter over the complete range of values. | Remember | 8 | CAEE009.08 |
| 15 | What are the different cases of Routh array? | Normal Routh array<br>A row of all zeros<br>First element of a row is zero but some and other elements are not zero | Remember | 8 | CAEE009.08 |
| 16 | What is effect of adding poles and zeros on stability? | The addition of poles to the transfer function has the effect of pulling the root locus to the right, making the system less stable. Addition of zeros to the transfer function has the effect of pulling the root locus to the left, making the system more stable. | Remember | 8 | CAEE009.08 |
| 17 | Define stability. | A linear relaxed system is said to have BIBIO stability if every bounded input results in a bounded output. | Understand | CLO 7 | CAEE009.07 |
| 18 | Define 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 are 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. | Understand | CLO 7 | CAEE009.07 |
| 19 | Define magnitude criterion. | The magnitude criterion states that S=Sa will be a point on root locus if for that value of S, magnitude of G(S)H(S) is equal to 1. \|G(S)H(S)\| = K(product of length of vectors from open loop zeros to the point S=Sa)/ (product of length of vectors from open loop poles to the point S=Sa) = 1. | Understand | CLO 7 | CAEE009.07 |
| 20 | Define a dominant pole. | The dominant pole is a pair of complex conjugate pair which decides the transient response of the system. | Understand | CLO 8 | CAEE009.08 |
| 21 | Define root loci. | The path taken by the roots of the open loop transfer function when the loop gain is varied from 0 to 1 are called root loci. | Understand | CLO 8 | CAEE009.08 |
| 22 | Define 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. | Understand | CLO 7 | CAEE009.07 |
| 23 | Define principle of argument. | The principles of arguments states that let F(S) are analytic function and if an arbitrary closed contour in a clockwise direction is chosen in the S-plane so that F(S) is analytic at every point of the contour. Then the corresponding F(S) plane contour mapped in the F(S) plane will encircle the origin N times in the anti clockwise direction, where N is the difference between number of | Understand | CLO 8 | CAEE009.08 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| | | poles and zeros of F(S) that are encircled by the chosen closed contour in the S-plane. | | | |
| 24 | Define break away and break in points. | At break away point the root locus breaks from the real axis to enter into the complex plane. At break in point the root locus enters the real axis from the complex plane. To find the break away or break in points, form a equation for K from the characteristic equation and differentiate the equation of K with respect to s. Then find the roots of the equation dK/dS = 0. The roots of dK/dS = 0 are break away or break in points provided for this value of root the gain K should be positive and real. | Understand | CLO 8 | CAEE009.08 |
| 25 | Define Proportional controller. | It is a device that produces a control signal which is proportional to the input error signal. | Understand | CLO 9 | CAEE009.09 |
| 26 | Define Proportional + Integral controller. | It is a device that produces a control signal consisting of two terms - one proportional to error signal and the other proportional to the integral of error signal. | Understand | CLO 9 | CAEE009.09 |
| 27 | Define Proportional + Derivative controller. | PD controller is a proportional plus derivative controller which produces an output signal consisting of two times - one proportional to error signal and other proportional to the derivative of the signal. | Understand | CLO 9 | CAEE009.09 |
| 28 | Define centroid. | The meeting point of the asymptotes with the real axis is called centroid. The centroid is given by Centroid = (sum of poles – sum of zeros) / (n-m)<br>n-number of poles, m-number of zeros. | Understand | CLO 8 | CAEE009.08 |
| 29 | Define angle criterion. | The angle criterion states that S=Sa will be the point on the root locus if for that value of S the argument or phase of G(S)H(S) is equal to an odd multiple of 180°. (Sum of the angles of vectors from zeros to the point S=Sa)- (Sum of the angles of vectors from poles to the point S=Sa) = ±180°(2q + 1). | Understand | CLO 8 | CAEE009.08 |
| UNIT - IV | | | | | |
| 1 | What is non minimum phase transfer function? | A transfer function which has one or more zeros in the right half s plane is known as non minimum phase transfer function. | Remember | 10 | CAEE009.10 |
| 2 | What are the different ways to obtain frequency response? | Bode plot<br>Polar plot<br>Nichols plot | Remember | 10 | CAEE009.10 |
| 3 | Why bode plot is called as logarithmic plot? | It is a plot of the logarithm of the magnitude of a sinusoidal transfer function. | Remember | 10 | CAEE009.10 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 4 | What are the basic factors are involved in bode plot? | Gain, Integral factor, Derivative factor and quadratic factor. | Remember | 10 | CAEE009.10 |
| 5 | How the frequency ratio is expressed in bode plot? | The frequency ratios are expressed in terms of octaves or decades | Remember | 10 | CAEE009.10 |
| 6 | Define break frequency. | The frequency at which the two asymptotes meet is called break frequency. | Remember | 12 | CAEE009.12 |
| 7 | What are the two different ways non minimum phase situation arises in bode plot? | One is simply when a system includes a non minimum phase element or elements. The other situation may arise in the case where a minor loop is unstable. | Remember | 12 | CAEE009.12 |
| 8 | What is dead time? | Transport lag, which is also called dead time, is of non minimum phase behavior and has an excessive phase lag with no attenuation at high frequencies. Such transport lags normally exist in thermal, hydraulic, and pneumatic systems. | Remember | 12 | CAEE009.12 |
| 9 | What is the polar plot of integral and derivative factors? | The polar plot of integral factor is the negative imaginary axis and derivative factor is the positive imaginary axis. | Remember | 12 | CAEE009.12 |
| 10 | What is the phase angle of type 1 system? | The phase angle is – 90 degree. | Remember | 11 | CAEE009.11 |
| 11 | What is the phase angle of type 2 system? | The phase angle is -180 degree. | Remember | 11 | CAEE009.11 |
| 12 | How to find stability in Nyquist encirclement point? | If the Nyquist plot of the open loop transfer function G(s) corresponding to the Nyquist control in the S-plane encircles the critical point –1+j0 in the counter clockwise direction as many times as the number of right half S-plane poles of G(s),the closed loop system is stable. | Remember | 11 | CAEE009.11 |
| 13 | Define is Nyquist contour. | The contour that encloses entire right half of S plane is called Nyquist contour. | Remember | 11 | CAEE009.11 |
| 14 | Define relative stability. | Relative stability is the degree of closeness of the system; it is an indication of strength or degree of stability. | Remember | 11 | CAEE009.11 |
| 15 | What is the value of error in the approximate magnitude plot of a quadratic factor with damping ratio =1 at the corner frequency? | The error is ± 6 db, for the quadratic factor with damping factor equal to one. | Remember | 11 | CAEE009.11 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 16 | Define frequency response. | A frequency response is the steady state response of a system when the input to the system is a sinusoidal signal | Understand | CLO 10 | CAEE009.10 |
| 17 | Define resonant peak (Δr). | The maximum value of the magnitude of closed loop transfer function is called Resonant Peak. | Understand | CLO 10 | CAEE009.10 |
| 18 | Define resonant frequency (Δf). | The frequency at which resonant peak occurs is called resonant frequency. | Understand | CLO 10 | CAEE009.10 |
| 19 | Define 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. | Understand | CLO 10 | CAEE009.10 |
| 20 | 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. | Understand | CLO 10 | CAEE009.10 |
| 21 | 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 frequency. | Understand | CLO 12 | CAEE009.12 |
| 22 | Define phase cross over frequency. | The frequency at which, the phase of open loop transfer functions is called phase cross over frequency Δpc. | Understand | CLO 12 | CAEE009.12 |
| 23 | Define phase margin. | The Phase margin is the amount of phase lag at the gain cross over frequency required to bring system to the verge of instability | Understand | CLO 12 | CAEE009.12 |
| 24 | Define gain cross over frequency. | The Gain cross over frequency Δgc is the frequency at which the magnitude of the open loop transfer function is unity. | Understand | CLO 12 | CAEE009.12 |
| 25 | Define 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 Δ. The other is a plot of the phase angle of a sinusoidal function versus log Δ. | Understand | CLO 11 | CAEE009.11 |
| 26 | Define corner frequency. | The frequency at which the two asymptotic meet in a magnitude plot is called Corner frequency. | Understand | CLO 11 | CAEE009.11 |
| 27 | Define Nyquist stability criterion. | If the Nyquist plot of the open loop transfer function G(s) corresponding to the Nyquist control in the S-plane encircles the critical point –1+j0 in the counter clockwise direction as many times as the number of right half S-plane poles of G(s),the closed loop system is stable. | Understand | CLO 11 | CAEE009.11 |
| 28 | Define is Nyquist contour. | The contour that encloses entire right half of S plane is called Nyquist contour. | Understand | CLO 11 | CAEE009.11 |
| 29 | Define relative stability. | Relative stability is the degree of closeness of the system; it is an indication of strength or degree of stability. | Understand | CLO 11 | CAEE009.11 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 30 | Define polar plot. | The Polar plot is a plot, which can be drawn between the magnitude and the phase angle of $G(j\omega)H(j\omega)$ by varying $\omega$ from zero to $\infty$. | Understand | CLO 11 | CAEE009.11 |
| UNIT - V | | | | | |
| 1 | State sampling theorem. | A continuous time signal can be completely represented in its samples and recovered back if the sampling frequency $Fs \geq 2Fmax$ where Fs is the sampling frequency and Fmax is the maximum frequency present in the signal. | Understand | CLO 13 | CAEE009.13 |
| 2 | Define phase lead. | A positive phase angle is called phase lead. | Understand | CLO 14 | CAEE009.14 |
| 3 | Define periodic sampling. | Sampling of a signal at uniform equal intervals is called periodic sampling. | Understand | CLO 13 | CAEE009.13 |
| 4 | Define phase variables. | The phase variables are defined as the state variables which are obtained from one of the system variables and its derivatives. | Understand | CLO 13 | CAEE009.13 |
| 5 | Define Nyquist rate. | The Sampling frequency equal to twice the highest frequency of the signal is called as Nyquist rate. fs=2fm. | Understand | CLO 14 | CAEE009.14 |
| 6 | Define similarity transformation. | The process of transforming a square matrix A to another similar matrix B by a transformation P-1 AP = B is called similarity transformation. The matrix P is called transformation matrix. | Understand | CLO 15 | CAEE009.15 |
| 7 | Define modal matrix. | The modal matrix is a matrix used to diagonalize the system matrix. It is also called diagonalization matrix. If A = system matrix. M = Modal matrix And $M^{-1}$ =inverse of modal matrix. Then $M^{-1}$ AM will be a diagonalized system matrix. | Understand | CLO 15 | CAEE009.15 |
| 8 | Define phase lag. | A negative phase angle is called phase lag. | Understand | CLO 13 | CAEE009.13 |
| 9 | Define phase lead compensator. | A system which has one pole and one dominating zero (the zero which is closer to the origin than all over zeros is known as dominating zero.) is known as lead network. If we want to add a dominating zero for compensation in control system then we have to select lead compensation network. | Understand | CLO 14 | CAEE009.14 |
| 10 | Define phase lag compensator. | A system which has one zero and one dominating pole ( the pole which is closer to origin that all other poles is known as dominating pole) is known as lag network. If we want to add a dominating pole for compensation in control system then, we have to select a lag compensation network. | Understand | CLO 14 | CAEE009.14 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 11 | Define phase lag-lead compensator. | With single lag or lead compensation may not satisfy design specifications. For an unstable uncompensated system, lead compensation provides fast response but does not provide enough phase margins whereas lag compensation stabilize the system but does not provide enough bandwidth. So we need multiple compensators in cascade. | Understand | CLO 15 | CAEE009.15 |
| 12 | Define order of system with respect to state vector. | All models of a system have the same number of elements in the sate vector. This number is referred to as the order of the system. | Understand | CLO 15 | CAEE009.15 |
| 13 | Define state space. | The n dimensional space whose coordinate axes consists of x1 axis, x2 axis, …, xn axis where x1, x2, …xn are state variables is called a state space. | Understand | CLO 15 | CAEE009.15 |
| 14 | Define input vector. | An input vector is a m x 1 column vector in which the elements are the m inputs u1, u2, …, um. | Understand | CLO 15 | CAEE009.15 |
| 15 | Define output vector. | An output vector is a p x 1 column vector in which the elements are the p outputs y1, y2, …, ym. | Understand | CLO 15 | CAEE009.15 |
| 16 | Define system matrix. | The system matrix is an n x n constant matrix relating the state variables of the system to the first derivatives of the state variables. | Remember | 14 | CAEE009.14 |
| 17 | Define input matrix. | The input matrix is an n x m constant matrix relating the input variables of the system to the first derivatives of the state variables. | Remember | 14 | CAEE009.14 |
| 18 | Define output matrix. | The output matrix is a p x n constant matrix relating the state variables to the outputs. | Remember | 14 | CAEE009.14 |
| 19 | Define transmission matrix. | The transmission matrix is a p x m contant matrix relating the inputs to the outputs. | Remember | 14 | CAEE009.14 |
| 20 | Define state equation. | The state equations are a set of first order differential equations, where in, the first derivatives of the variables are expressed in terms of the state variables and the inputs of the system. $X(t)=Ax(t)+Bu(t)$ is the state eqaution of the system. | Remember | 14 | CAEE009.14 |
| 21 | Define companion form. | The matrix A is said to be in bush form or companion form when all its off diagonal elements are 1s and the last row is comprised of the negative of the coefficients of the originaldifferential equation written in reverse order, and all other elements in the matrix zero. | Remember | 14 | CAEE009.14 |
| 22 | Define normal form. | The diagonal canonical form is also called the normal form. In this form, the matrix A will be a diagonal matrix, the main diagonal elements of the matrix A are eigen values and all other elements in the matrix are zero. | Remember | 14 | CAEE009.14 |

| S No | QUESTION | ANSWER | Blooms Level | CLO | CLO Code |
|---|---|---|---|---|---|
| 23 | Define canonical form. | The system matrix A is said to br in canonical form, if all its half diagonal elements of the matrix A are zero, and its main diagonal elements are equal to the roots of the characteristic equation. | Remember | 14 | CAEE009.14 |
| 24 | Define resolvent matrix. | $\phi(s)=[sI-A]^{-1}$ is called the resolvent matrix. | Remember | 14 | CAEE009.14 |
| 25 | Define state transtion matrix. | The solution of the linear nonhomogeneous state equation is called the state trantion matrix. | Remember | 14 | CAEE009.14 |
| 26 | Define forced response. | The froced response is the response or output of the system when the inputs are present. | Remember | 14 | CAEE009.14 |
| 27 | Define free response. | The force response is the response or output of the systems when the inputs are zero. It is due to initial conditions only. | Remember | 14 | CAEE009.14 |
| 28 | Mention the properties of state transition matrix. | The state transition matrix is a matrix that satisfies the above linear homogeneous state equation. | Remember | 14 | CAEE009.14 |
| 29 | Define input matrix. | The input matrix is an n x m constant matrix relating the input variables of the system to the first derivatives of the state variables. | Remember | 14 | CAEE009.14 |
| 30 | What is Jordan canonical form | The state space system having multiple roots then Jordan canonical approach is used | Remember | 14 | CAEE009.14 |

**Signature of the Faculty** **Signature of the HOD**