CHAPTER-9. CONTROL SYSTEM

[1] An open loop system represented by the transfer function \( G(s) = \frac{(s-1)}{(s+2)(s+3)} \) is
A. stable and of the minimum phase type
B. stable and of the non-minimum phase type
C. unstable and of the minimum phase type
D. unstable and of the non-minimum phase type

[2] The open loop transfer function \( G(s) \) of a unity feedback control system is given as,
\[ G(s) = \frac{k(s+2/3)}{s^2(s+2)} \]
From the root locus, it can be inferred that when \( k \) tends to positive infinity,
A. three roots with nearly equal real parts exist on the left half of the s-plane
B. one real root is found on the right half of the s-plane
C. the root loci cross the \( j\omega \) axis for a finite value of \( k; k \neq 0 \)
D. three real roots are found on the right half of the s-plane

[3] Given that
\[ A = \begin{bmatrix} -5 & -3 \\ 2 & 0 \end{bmatrix} \text{ and } I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \]
then the value of \( A^3 \) is [GATE2012]
A. 15A+12I
B. 19A+30I
C. 17A+15I
D. 17A+21I

\[ \begin{bmatrix} 2 & 1 \\ 4 & -1 \end{bmatrix} \]
is decomposed into a product of a lower triangular matrix \([L]\) and an upper triangular matrix \([U]\). The properly decomposed \([L]\) and \([U]\) matrices respectively are........The options A,B,C,D are given below.

\[ \begin{bmatrix} 1 & 0 \\ 4 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 1 \\ 0 & -2 \end{bmatrix}, \quad \begin{bmatrix} 2 & 0 \\ 4 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}, \quad \begin{bmatrix} 1 & 0 \\ 4 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 2 & 1 \\ 0 & -1 \end{bmatrix}, \quad \begin{bmatrix} 2 & 0 \\ 4 & -3 \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 0.5 \\ 0 & 1 \end{bmatrix} \]

Ans: none of the above

[5] The input \( x(t) \) of a system are related as \( y(t) = \int_{-\infty}^{t} x(\tau) \cos(3\tau) d\tau \). The system is [GATE2012]
A. time-invariant and stable
B. stable and not time-invariant
C. time-invariant and not stable
D. not time-invariant and not stable

[6] The feedback system shown below oscillates at 2 rad/s when [GATE2012]
7] The Fourier transform of a signal \( h(t) \) is \( H(j\omega) = (2\cos\omega)(\sin2\omega)/\omega \). The value of \( h(0) \) is [GATE2012]
   A. 1/4
   B. 1/2
   C. 1
   D. 2

8] The state variable description of an LTI system is given by

\[
\begin{align*}
    \begin{pmatrix}
    x_1 \\
    x_2 \\
    x_3 \\
    \end{pmatrix}
    &=
    \begin{pmatrix}
    0 & a_1 & 0 \\
    0 & 0 & a_2 \\
    a_3 & 0 & 0 \\
    \end{pmatrix}
    \begin{pmatrix}
    x_1 \\
    x_2 \\
    x_3 \\
    \end{pmatrix}
    +
    \begin{pmatrix}
    0 \\
    0 \\
    1 \\
    \end{pmatrix}
    u
\end{align*}
\]

\[
y = \begin{pmatrix} 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}
\]

where \( y \) is the output and \( u \) is the input. The system is controllable for, [GATE2012]
   A. \( a_1 \neq 0, a_2 = 0, a_3 \neq 0 \)
   B. \( a_1 = 0, a_2 = 0, a_3 \neq 0 \)
   C. \( a_1 = 0, a_2 = 0, a_3 = 0 \)
   D. \( a_1 \neq 0, a_2 \neq 0, a_3 = 0 \)

9] The state transition diagram for the logic circuit shown is [GATE2012]

Ans: D

10] Given that

\[
A = \begin{bmatrix}
    -5 & -3 \\
    2 & 0 \\
\end{bmatrix}
\]

and

\[
I = \begin{bmatrix}
    1 & 0 \\
    0 & 1 \\
\end{bmatrix}
\]

then the value of \( A^3 \) is [GATE2012]
   A. 15A+12I
B. 19A+30I  
C. 17A+15I  
D. 17A+21I

[11] A system is described by the following state and output equations  
\[ \frac{dx_1(t)}{dt} = -3x_1(t) + x_2(t) + 2u(t) \]  
\[ \frac{dx_2(t)}{dt} = -2x_2(t) + u(t) \]  
\( y(t) = x_1(t) \)  
where \( u(t) \) is the input and \( y(t) \) is the output.

The system transfer function is  
A. \( \frac{s+2}{s^2+5s-6} \)  
B. \( \frac{s+3}{s^2+5s+6} \)  
C. \( \frac{2s+5}{s^2+5s+6} \)  
D. \( \frac{2s-5}{s^2+5s-6} \)  
Ans: C

[12] A two-port network is defined by the relation: [IES 2010]  
\( I = 5V_1 + 3V_2 \)  
\( I_2 = 2V_1 - 7V_2 \)  
The value of \( Z_{12} \) is  
A. 3  
B. -3  
C. 3/41  
D. 2/31  
Ans: C

[13] The Z-transform of \( x(K) \) is given by [IES 2010]  
\[ x(Z) = \frac{(1-e^{-T})z^{-1}}{(1-z^{-1})(1-e^{-T}z^{-1})} \]  
The initial value of \( x(0) \) is  
A. Zero  
B. 1  
C. 2  
D. 3  
Ans: A

[14] Consider the following statements with reference to the phase plane:

1. They are general and applicable to a system of any order.  
2. Steady state accuracy and existence of limit cycle can be predicted.  
3. Amplitude and frequency of limit cycle if exists can be evaluated.  
4. Can be applied to discontinuous time system.  
Which of the above statements are correct? [IES2010]  
A. 1, 2, 3 and 4  
B. 2 and 3 only  
C. 3 and 4 only  
D. 2, 3 and 4 only  
Ans: B

[15] For the circuit shown below, the natural frequencies at port 2 are given by \( s+2=0 \) and \( s+5=0 \), without knowing which refers to open-circuit and which to short-circuit. Then the impedences \( Z_{11} \) and \( Z_{22} \) are given respectively by [IES2010]
A. \( K_1 \frac{(s+5)}{(s+2)}, K_2 \frac{(s+2)}{(s+5)} \)
B. \( K_1 \frac{(s+2)}{(s+5)}, K_2 \frac{(s+5)}{(s+2)} \)
C. \( K_1 \frac{(s)}{(s+2)}, K_2 \frac{(s+2)}{(s+5)} \)
D. \( K_1 \frac{(s+2)}{(s+5)}, K_2 \frac{(s+2)}{(s+5)} \)

Ans: C

[16] Consider the following statements in connection with two-position controller:
1. If the controller has a 4\% neutral zone, its positive error band will be 2\% and negative error band will be 8\%.
2. The neutral zone is also known as dead band D.
3. The controller action of a two-position controller is very similar to that of a pure on-off controller.
4. Air-conditioning system works essentially on a two-position control basis.
Which of the above statements are correct? [IES2010]
A. 1, 2 and 3 only.
B. 2, 3 and 4 only.
C. 2 and 4 only.
D. 1, 2, 3 and 4

Ans: B

[17] The polar plot of an open loop stable system is shown below. The closed loop system is [GATE 2009]

A. Always stable
B. Marginally stable
C. Unstable with one pole on the RH s-plane
D. Unstable with two poles on the RH s-plane

Ans: C

[18] The open loop transfer function of a unity feedback system is given by \( G(s) = \frac{e^{-0.1s}}{s} \). The gain margin of this system is [GATE 2009]
A. 11.95 dB
B. 17.67 dB
C. 21.33 dB
D. 23.9 dB

Ans: D
The first two rows of Routh’s tabulation of a third order equation are as follows.

\[
\begin{align*}
s^3 & \quad 2 & \quad 2 \\
s^2 & \quad 4 & \quad 4 \\
\end{align*}
\]

This means there are [GATE 2009]

A. Two roots at \( s = \pm j \) and one root in right half s-plane
B. Two roots at \( s = \pm j^2 \) and one root in left half s-plane
C. Two roots at \( s = \pm j^2 \) and one root in right half s-plane
D. Two roots at \( s = \pm j \) and one root in left half s-plane

Ans: D

The asymptotic approximation of the log magnitude vs frequency plot of a system containing only real poles and zeros is shown. Its transfer function is [GATE 2009]

A. \( \frac{10(s+5)}{[s(s+2)(s+25)]} \)
B. \( \frac{1000(s+5)}{[s^2(s+2)(s+25)]} \)
C. \( \frac{100(s+5)}{[s^2(s+2)(s+25)]} \)
D. \( \frac{80(s+5)}{[s^2(s+2)(s+25)]} \)

Ans: B

The trace and determinant of a 2x2 matrix are known to be -2 and -35 respectively. Its eigenvalues are [GATE 2009]

A. -30 and -5
B. -37 and -1
C. -7 and 5
D. 17.5 and -2

Ans: C

A Linear Time Invariant system with an impulse response \( h(t) \) produces output \( y(t) \) when input \( x(t) \) is applied. When the input \( x(t-\tau) \) is applied to a system with impulse response \( h(t-\tau) \), the output will be [GATE 2009]

A. \( y(t) \)
B. \( y(2(t-\tau)) \)
C. \( y(t-\tau) \)
D. \( y(t-2\tau) \)

Ans: D

For the Y-bus matrix of a 4-bus system given in per unit, the buses having shunt elements are [GATE 2009]

\[
Y_{bus} = j
\begin{bmatrix}
-5 & 2 & 2.5 & 0 \\
2 & -10 & 2.5 & 4 \\
2.5 & 2.5 & -9 & 4 \\
0 & 4 & 4 & -8
\end{bmatrix}
\]
A. 3 and 4
B. 2 and 3
C. 1 and 2
D. 1,2 and 4
Ans:C
[24] The unit step response of a unity feedback system with open loop transfer function \( G(s) = \frac{K}{(s+1)(s+2)} \) is shown in the figure. The value of \( K \) is \([\text{GATE} 2009]\)

A. 0.5
B. 2
C. 4
D. 6
Ans: D
[25] For the driving point impedance function, \( Z(s)=\frac{as^2+7s+3}{s^2+3s+b} \), the circuit realization is shown below. The values of \( a \) and \( b \) respectively are \([\text{IES2010}]\)
A. 4 and 5
B. 2 and 5
C. 2 and 1
D. 2 and 3
Ans: C
[26] For the following driving point impedance functions, which of the following statements is true? \([\text{IES2010}]\)

\[
Z_1(s)=(s+2)/(s^2+3s+5) \\
Z_2(s)=(s+2)/(s^2+5) \\
Z_3(s)=(s+2)/(s^2+2s+1) \\
Z_4(s)=(s+2)(s+4)/(s+1)(s+3)
\]
A. \( Z_1 \) is not positive real
B. \( Z_1 \) is positive real
C. \( Z_3 \) is positive real
D. \( Z_4 \) is positive real
Ans: D
[27] The steady state error of a unity feedback linear system for a unit step input is 0.1. The steady state error of the same system, for a pulse input \( r(t) \) having a magnitude of 10 and a duration of one second, as shown in the figure is \([\text{GATE2011}]\)

A. 0
B. 0.1
C. 1
D. 10

Ans: A

[28] A point z has been plotted in the complex plane, as shown in figure below [GATE2011]

The plot of the complex number \( y = \frac{1}{z} \) is........ The options A, B, C, D are given below.

Ans: D

[29] The system represented by the input-output relationship \( y(t) = \int_{-\infty}^{t} x(\tau) d\tau, t > 0 \) is

A. Linear and casual  
B. Linear but not casual  
C. Casual but not linear  
D. Neither linear nor casual

[30] For the system \( \frac{2}{s+1} \), the approximate time taken for a step response to reach 98% of its final value is

A. 1s  
B. 2s  
C. 4s  
D. 8s

[33] Given the finite length input \( x[n] \) and the corresponding finite length output \( y[n] \) of an LTI system as shown below, the impulse response \( h[n] \) of the system is

A. \( h[n] = \{1,0,0,1\} \)  
B. \( h[n] = \{1,0,1\} \)  
C. \( h[n] = \{1,1,1,1\} \)  
D. \( h[n] = \{1,1,1\} \)

[34] The frequency response of \( G(s) = \frac{1}{s(s+1)(s+2)} \) plotted in the complex \( G(j\omega) \) plane (for \( 0 < \omega < \infty \)) is...... Options A, B, C, D are given below

Ans: A
[35] The system \( x = Ax + Bu \) with

\[
A = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}
\]

is

A. stable and controllable
B. stable but uncontrollable
C. unstable but controllable
D. unstable and uncontrollable

[36] The characteristic equation of a closed-loop system is \( a(s+1)(s+3)+k(s+2)=0, k>0 \). Which of the following statements is true?

A. Its roots are always real
B. It cannot have a breakaway point in the range \(-1<\text{Re}[s]<0\)
C. Two of its roots tend to infinity along the asymptotes \( \text{Re}[s]=-1 \)
D. It may have complex roots in the right half plane

[37] The frequency response of a linear system \( G(j\omega) \) is provided in the tabular form below

| \( |G(j\omega)| \) | 1.3 | 1.2 | 1.0 | 0.8 | 0.5 | 0.3 |
| \( \angle G(j\omega) \) | -130° | -140° | -150° | -160° | -180° | -200° |

A. 6dB and 30°
B. 6dB and -30°
C. -6dB and 30°
D. -6dB and -30°

[38] An openloop system represented by the transfer function \( G(s) = \frac{(s+1)}{(s+2)}(s+3) \) is

A. stable and of the minimum phase type
B. stable and of the non-minimum phase type
C. unstable and of the minimum phase type
D. stable and of the non-minimum phase type

[39] The open loop transfer function \( G(s) \) of a unity feedback control system is given as, \( G(s) = \frac{k(s+2/3)}{s^2(s+2)} \) From the root locus, it can be inferred that when \( k \) tends to positive infinity.

A. three roots with nearly equal real parts exist on the left half of the s-plane
B. one real root is found on the right half of the s-plane
C. the root loci cross the j\( \omega \) axis for a finite value of \( k \); \( k \) not equal to 0
D. three real roots are found on the right half of the s-plane

[40] The response \( h(t) \) of a linear time invariant system to an impulse \( \delta(t) \), under initially relaxed condition is \( h(t) = e^{-t} + e^{-2t} \). The response of this system for a unit step input \( u(t) \) is

A. \( u(t) + e^{-t} + e^{-2t} \)
B. \( (e^{-t} + e^{-2t}) u(t) \)
C. \( (1.5 - e^{-t} - 0.5e^{-2t}) u(t) \)
D. \( e^{-t}\delta(t) + e^{-2t}u(t) \)