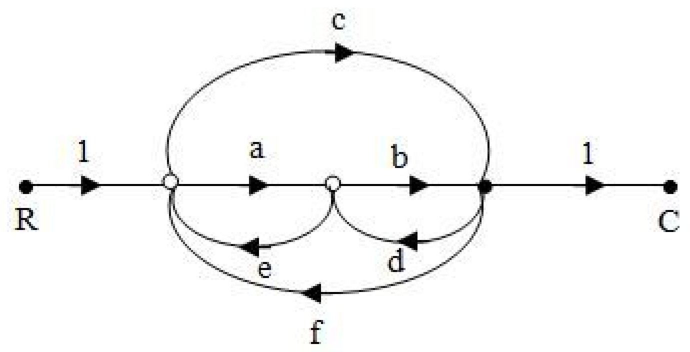
Section Title : One Mark Questions
Total Questions: 10
Max Marks : 1
-ve Marks :0.33

Question No: 1

Analysis

In the following signal flow graph, the number of individual loops is ________.



Not Attempted -- **Correct Answer : 5 & Valid Answer Range :5,5**

Video Solution

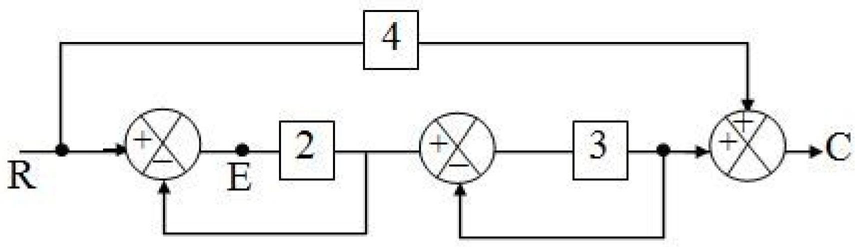
Solution :

Individual loop gains $L_1 = ae$, $L_2 = bd$, $L_3 = cde$, $L_4 = abf$, $L_5 = fc$

Question No: 2

Analysis

In the block diagram given below. The gain from R to E is ______.



Not Attempted -- **Correct Answer : 0.33 & Valid Answer Range :0.3,0.4**

Video Solution

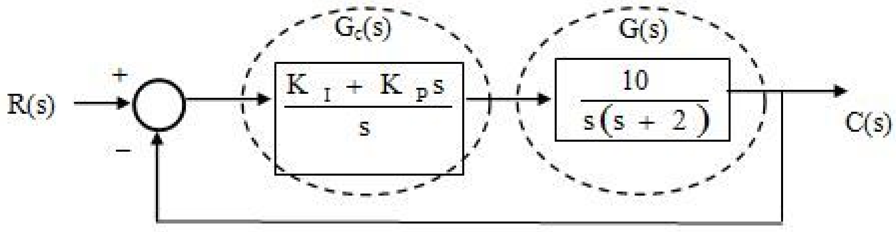
Solution :

$$\frac{E}{R} = \frac{1[1-(-3)]}{1-[-2-3]+[-2\times -3]} = \frac{4}{12} = \frac{1}{3} = 0.33$$

Question No: 3

Analysis

Open loop transfer function G(s) with compensator $G_c(s)$ is shown in figure



The closed loop system is stable when

(A) $K_p = \frac{K_I}{2}$

(B) $K_p < \frac{K_I}{2}$

(C) $K_p > \frac{K_I}{2}$

(D) $K_p = K_I$

Not Attempted -- Correct Answer : C

Solution :

$$C.E = s^3 + 2s^2 + 10K_p s + 10K_I = 0$$

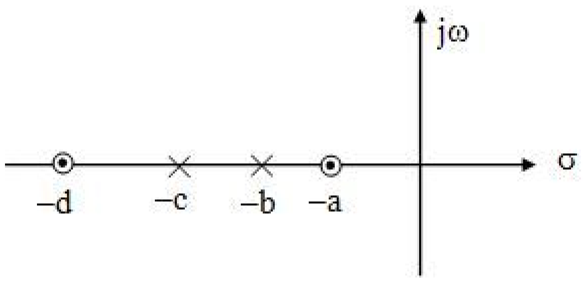
$$20K_p > 10K_I$$

$$K_P > K_I / 2$$

Question No: 4

Analysis

The pole zero plot of Lead - lag compensator is given below



The system will work as lag-lead compensator when

(A) $a > b,\ c > d$

(B) $a = b,\ c = d$

(C) $a < b,\ c < d$

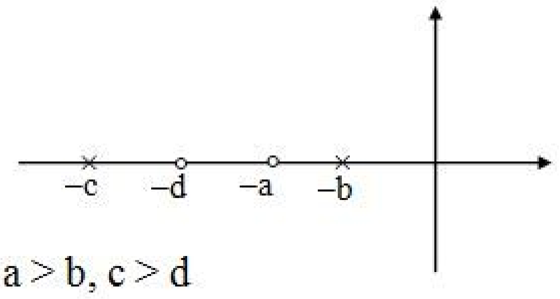
(D) $a > b > c > d$

Not Attempted -- Correct Answer : A

Video Solution

Solution :

Lag – Lead compensator pole –zero pattern is

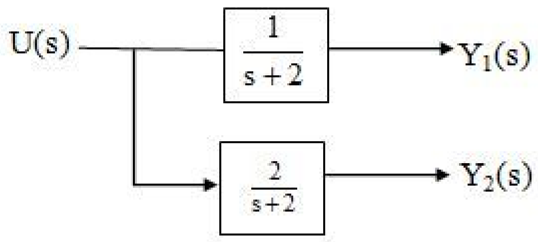


$\therefore\ a > b,\ c > d$

Question No: 5

Analysis

The block diagram of the system is



The number of state variables required to represent this state variable representation form is _______.

Not Attempted -- Correct Answer : 1 & Valid Answer Range :1,1

Video Solution

Solution :

$$Y_1(s) = \frac{U(s)}{s+2}$$

$$Y_2(s) = \frac{2U(s)}{s+2}$$

Let $Y_1 = X_1$

$Y_2 = 2X_1$

$$X_1(s) = \frac{U(s)}{s+2}$$

$$\dot{x}_1 = -2x_1 + u(t)$$

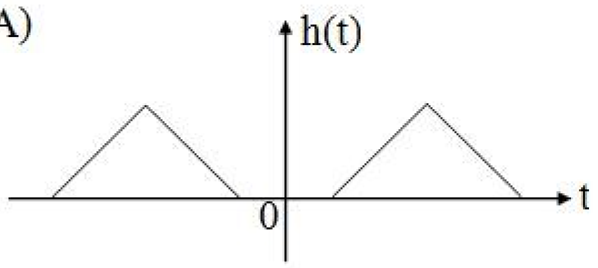
$\therefore$ In state variable conversion only 1 variable is required

Question No: 6

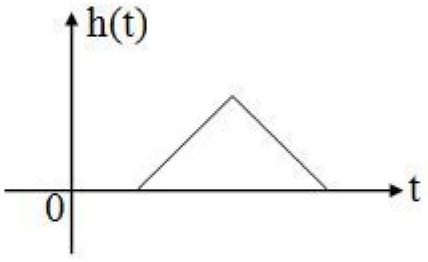
Analysis

Which of the following can be impulse response of causal system?

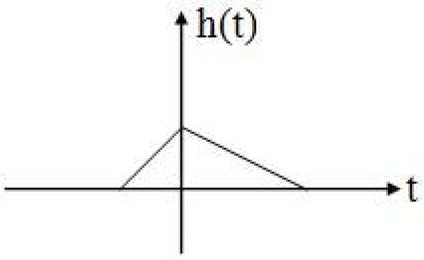
(A)



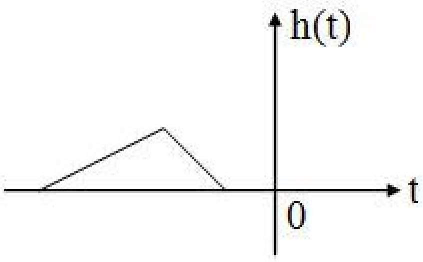
(B)



(C)



(D)



Not Attempted -- Correct Answer : B

Video Solution

Solution :

A system is said to be causal if $h(t) = 0$ for $t < 0$.

Option (B) is satisfying this condition. So, it is a causal system.

Question No: 7

Analysis

The unilateral Laplace transform of f(t) is $\frac{1}{s^2+1}$.

The unilateral Laplace transform of t^2 f(t) is

(A) $-\frac{s}{(s^2+s+1)^3}$

(B) $-\frac{2s+1}{(s^2+s+1)^4}$

(C) $\frac{-3s^2+1}{(s^2+1)^3}$

(D) $\frac{6s^2-2}{(s^2+1)^3}$

Not Attempted -- Correct Answer : D

Video Solution

Solution :

$$f(t) \xrightarrow{LT} F(s) = \frac{1}{s^2+1}$$

$$t^2 f(t) \xrightarrow{LT} \frac{d^2}{ds^2} F(s) = \frac{6s^2-2}{(s^2+1)^3}$$

Question No: 8

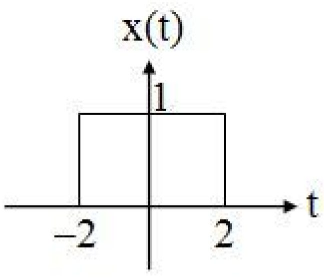
Analysis

Consider signal $x(t) = \begin{cases} 1, & |t| \le 2 \\ 0, & |t| > 2 \end{cases}$. Let δ(t) denote the unit impulse (Dirac-delta) function. The value of the integral $\int_0^5 2x(t-3)\delta(t-4)\,dt$ is ________.

Not Attempted -- Correct Answer : 2 & Valid Answer Range :2,2

Solution :

Given,



From sifting property $\int_{t_1}^{t_2} x(t)\delta(t-t_0)dt = x(t_0) \quad t_1 \le t_0 \le t_2$

$= 0 \quad$ otherwise

$$\int_0^5 2x(t-3)\delta(t-4)\,dt = 2x(4-3) = 2x(1) = 2\times 1 = 2$$

Question No: 9

Analysis

Consider the discrete – time signal $x(n) = \left(\frac{1}{3}\right)^n u(n)$,

where $u(n) = \begin{cases} 1, & n \geq 0. \\ 0, & n < 0 \end{cases}$.

Define the signal y(n) as $y(n) = x(-n)$. Then $\sum_{n=-\infty}^{\infty} y(n)$ equals to

Not Attempted -- Correct Answer : 1.5 & Valid Answer Range :1.5,1.5

Video Solution

Solution :

Given $x(n) = \left(\frac{1}{3}\right)^n u(n)$ and $y(n) = x(-n)$.

$$\sum_{n=-\infty}^{\infty} y(n) = \sum_{n=-\infty}^{\infty} \left(\frac{1}{3}\right)^{-n} u(-n)$$

$$= \sum_{n=-\infty}^{0} \left(\frac{1}{3}\right)^{-n} = 1 + \frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \ldots\ldots$$

$$= \frac{\text{First term}}{1 - \text{Common ratio}}$$

$$= \frac{1}{1 - \frac{1}{3}} = \frac{3}{2}$$

Question No: 10

Analysis

The Fourier transform of $x(t) = e^{-at}u(-t)$, where u(t) is the unit step function,

(A) exists for any real value of ‘a’

(B) does not exists for any real value of ‘a’

(C) exists if the real value of ‘a’ is strictly negative

(D) exists if the real value of ‘a’ is strictly positive

Not Attempted -- Correct Answer : C

Solution :

Given $x(t) = e^{-at} u(-t)$

Dirichlet's condition for convergence of Fourier transform is

$$\int_{-\infty}^{\infty} |x(t)| dt < \infty$$

$$\int_{-\infty}^{\infty} |x(t)| dt = \int_{-\infty}^{0} e^{-at} dt < \infty \text{ only if } \mathrm{Re}\,(a) < 0$$

Section Title : Two Marks Questions

Total Questions: 20

Max Marks : 2

-ve Marks :0.66

Question No: 11

Analysis

The characteristic equation of a system is given as $s^3+9s^2+4s+k = 0$;

If the system is marginally stable the values of k and undamped natural frequency ω_n respectively

(A) 36, 2 rad/sec

(B) 36, 4 rad/sec

(C) 18, 2 rad/sec

(D) 18, 4 rad/sec

Not Attempted -- Correct Answer : A

Video Solution

Solution :

s^3	1	4
s^2	9	k
s^1	$\frac{36-k}{9}$	
s^0	k	

For marginally stable system

$$\frac{36-k}{9} = 0 \Rightarrow k = 36$$

Auxiliary equation $A(s) = 9s^2 + k = 0$

$$9s^2 + 36 = 0$$

$$s = \pm 2j$$

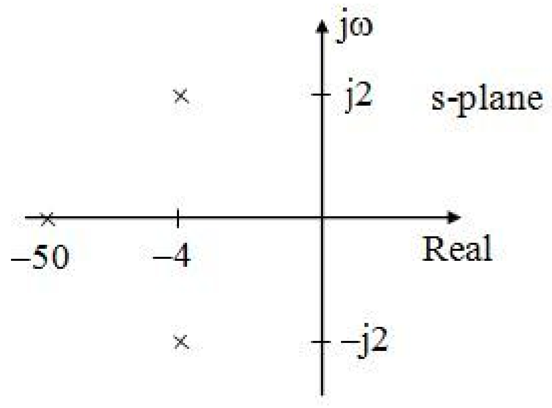
$$\omega_n = 2 \text{ rad/sec}$$

Question No: 12

Analysis

The closed loop poles of a system are shown in figure below.

The time taken to settle with in 2 % of tolerance is _______ (in sec)



Not Attempted -- Correct Answer : 1 & Valid Answer Range :1,1

Solution :

Characteristic equation:

$(s+50)(s+4-2j)(s+4+2j) = 0$

Using dominate pole approximation

$\approx (s+4-2j)(s+4+2j) = 0$

$(s+4)^2 + 4 = 0$

$s^2 + 8s + 20 = 0 \equiv s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$

$\therefore \zeta\omega_n = 4$

$$\therefore t_s(2\%\ \text{tolerance}) = \frac{4}{\zeta\omega_n} = \frac{4}{4} = 1\text{sec}$$

Question No: 13

Analysis

Given CLTF $\frac{C(s)}{R(s)} = \frac{20s^2}{(s+1)(s+3)(s+5)}$; The natural response of the system output when excited with an input of $(1+2t+3\frac{t^2}{2})\,u(t)$ is

(A) $-5e^{-t} + 10e^{-3t} - 9e^{-5t}$

(B) $5e^{-t} + 10e^{-3t} - 9e^{-5t}$

(C) $5e^{-t} + 10e^{-3t} + 9e^{-5t}$

(D) $-10e^{-t} + 10e^{-3t} - 9e^{-5t}$

Not Attempted -- Correct Answer : A

Video Solution

Solution :

$$r(t) = \left(1 + 2t + 3\frac{t^2}{2}\right)u(t) \to R(s) = \frac{1}{s} + \frac{2}{s^2} + \frac{3}{s^3}$$

$$C(s) = \frac{20s^2}{(s+1)(s+5)(s+3)}\cdot\left(\frac{1}{s} + \frac{2}{s^2} + \frac{3}{s^3}\right)$$

$$\Rightarrow C(s) = \frac{20(s^2 + 2s + 3)}{s(s+1)(s+5)(s+3)}$$

$$\Rightarrow C(s) = \frac{4}{s} - \frac{5}{s+1} + \frac{10}{s+3} - \frac{9}{s+5}$$

$L^{-1}[C(s)] = c(t) = 4 - 5e^{-t} + 10e^{-3t} - 9e^{-5t}$

The natural response (or) transient response component can be given as

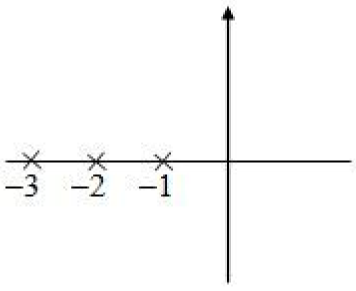
$$[c(t)]_{natural} = -5e^{-t} + 10e^{-3t} - 9e^{-5t}$$

Question No: 14

Analysis

A system is described by the state equation $\dot{X} = AX + BU$.

The output is given by $Y = CX$. The system poles are given as shown in figure below



The state space representation corresponding matrix "A" is

(A) $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$ (B) $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 6 & 11 & 6 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 1 \\ -6 & -11 & -6 \end{bmatrix}$ (D) $\begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$

Not Attempted -- Correct Answer : A

Video Solution

Solution :

$$TF = \frac{k}{(s+1)(s+2)(s+3)} = \frac{k}{s^3 + 6s^2 + 11s + 6}$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$$

Question No: 15

Analysis

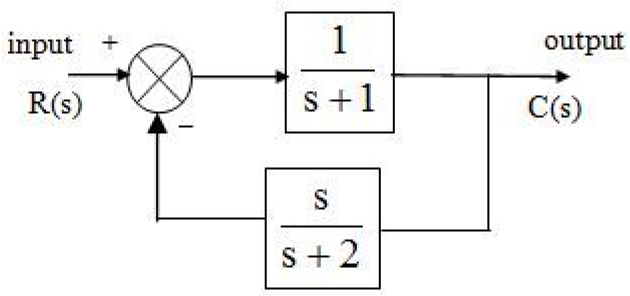
For the feedback control system shown in figure below, the sensitivity of overall gain with respect to feedback path gain is

(A) $\frac{-1}{s^2 + 4s + 2}$

(B) $\frac{-s}{s^2 + 4s + 2}$

(C) $\frac{s}{s^2 + 4s + 2}$

(D) $\frac{1}{s^2 + 4s + 2}$



Not Attempted -- Correct Answer : B

Solution :

$$\text{Let } M = \frac{G}{1+GH}$$

$$G = \frac{1}{s+1},\ H = \frac{s}{s+2}$$

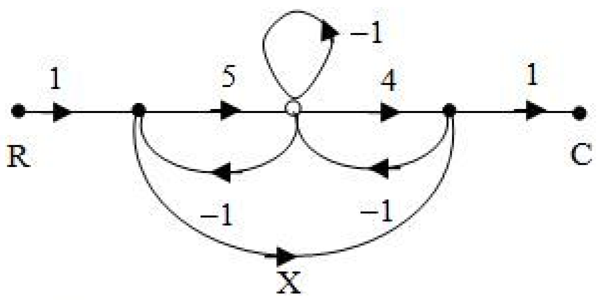
$$S_H^M = \frac{\partial M}{\partial H} \times \frac{H}{M} = \frac{-GH}{1+GH}$$

$$= \frac{-\frac{1}{s+1} \times \frac{s}{s+2}}{1+\frac{1}{s+1} \times \frac{s}{s+2}} = -\left[\frac{s}{s^2+4s+2}\right]$$

Question No: 16

Analysis

Consider the signal flow graph of a system is shown in figure below.



If the gain $\frac{C}{R}$ is 4 then the value of X is________.

Not Attempted -- Correct Answer : 4 & Valid Answer Range :4,4

Video Solution

Solution :

Forward path gains = (1) (5) (4) (1) = 20

(1) (X) (1) = X

Loop gains = –5,–4 and –1, X

$$\frac{C}{R} = \frac{20+X[1+1]}{1-(-5-4-1+X)} = \frac{20+2X}{11-X}$$

$$\frac{20+2X}{11-X} = 4$$

$$20 + 2X = 44 - 4X$$

$$6X = 24$$

$$X = 4$$

Question No: 17

Analysis

Closed loop transfer function of a unity feedback system is $\frac{k}{s^2+6s+5+k}(k>0)$.

Consider the points in the s-plane $s_1 = -3+j3$, $s_2 = -3-j4$ with respect to the root Loci diagram

(A) s_1 is on the root loci diagram but not s_2

(B) s_2 is on the root loci diagram but not s_1

(C) both are on the root Loci diagram

(D) both are not on the root Loci diagram

Not Attempted -- Correct Answer : C

Video Solution

Solution :

Characteristic equation = 1+G(s)H(s) = 0

$$s^2 + 6s + 5 + k = 0$$

$$1+\frac{k}{(s^2+6s+5)}=0$$

$$G(s)H(s)=\frac{k}{(s^2+6s+5)}$$

$$=\frac{k}{(s+5)(s+1)}$$

$$\angle\frac{k}{(s+5)(s+1)}\bigg|_{at\ s=-3+j3}$$

$$=\angle\frac{k}{(-3+j3+5)(-3+j3+1)}$$

$$=-(\tan^{-1}\frac{3}{2}+180^\circ-\tan^{-1}\frac{3}{2})$$

$$=-180^\circ=-\pi$$

Phase is equal to odd multiplier of π

$\therefore$ s_1 is on root locus diagram.

$$\angle\frac{k}{(s+5)(s+1)}\bigg|_{at\ s=-3-j4}$$

$$\angle\frac{k}{(-3-j4+5)(-3-j4+1)}$$

$=-[-\tan^{-1}(4/2)+180^\circ+\tan^{-1}(4/2)]$

$=-180^\circ$

Phase is equal to odd multiplier of π

$\therefore$ s_2 is on root locus diagram

Question No: 18

Analysis

The point in the s-plane s = –2, to be lie on the root loci diagram of a system with loop transfer function $\frac{k}{s(s+4)(s+10)}$, the value 'k' is

(A) 8

(B) 16

(C) 32

(D) Such k value will not exist

Not Attempted -- **Correct Answer :** **C**

Solution :

$k|_{s=-2} = |s(s+4)\,(s+10)|$

$= |(-2)\,(-2+4)\,(-2+10)|$

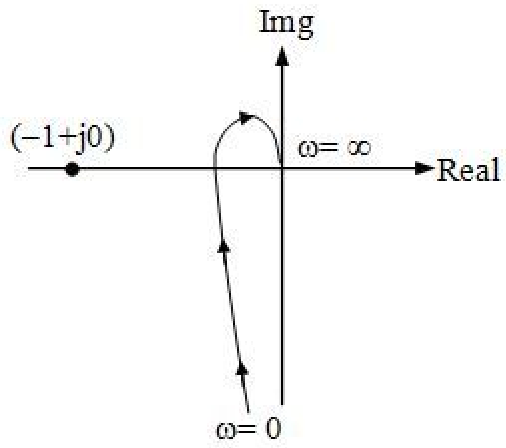
$= |(2)\,(2)\,(8)|$

$k = 32$

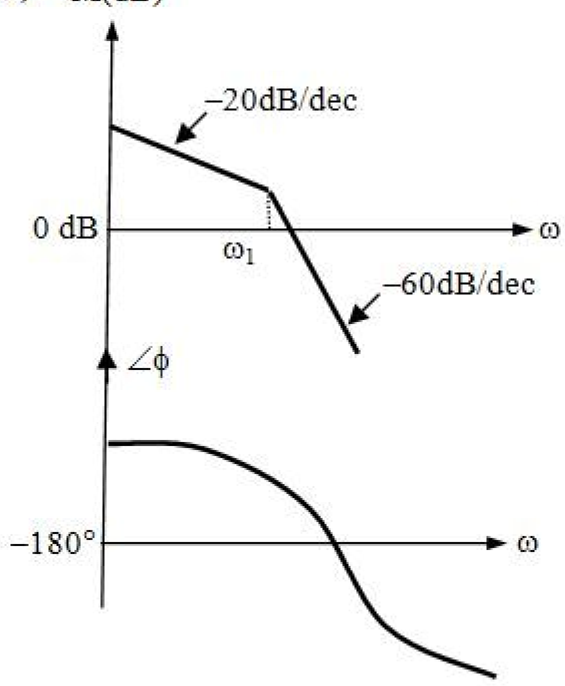
Question No: 19

Analysis

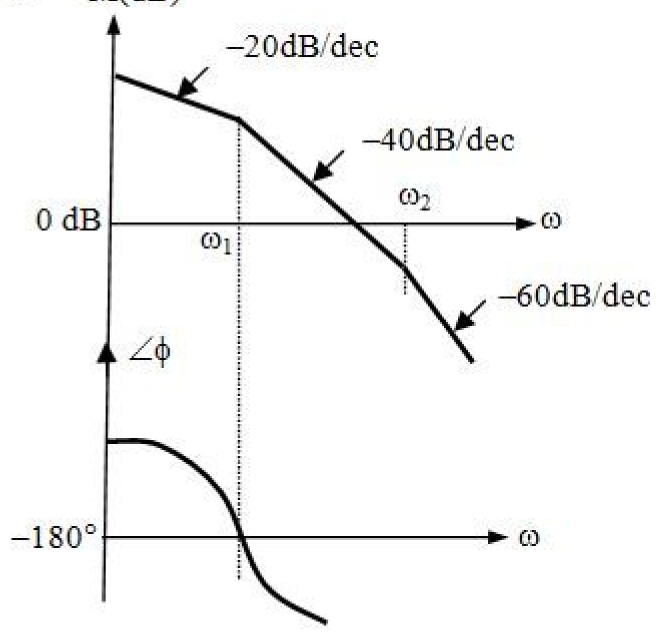
The Nyquist plot for a control system over the frequency range $\omega = 0$ to $\omega = \infty$ is shown in figure. The Bode plot for the system will be



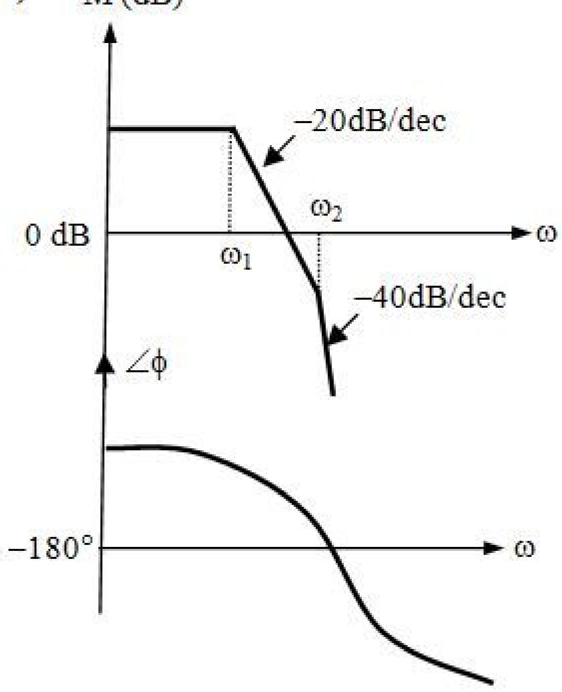
(A)



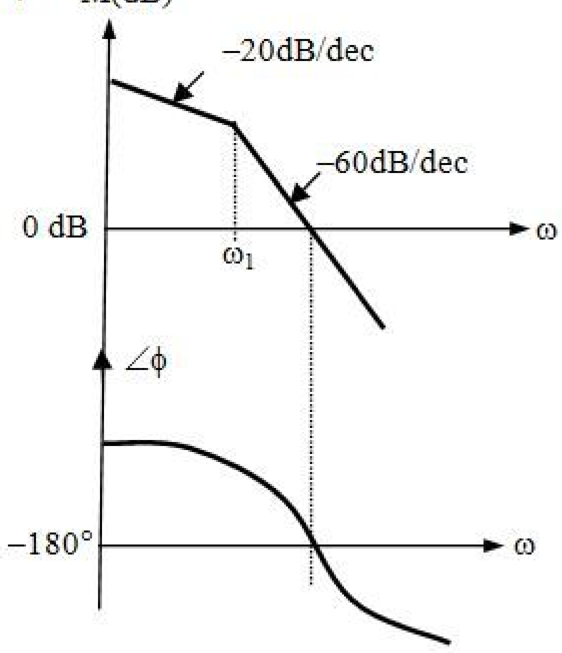
(B)



(C)



(D)



Not Attempted -- **Correct Answer : A**

Video Solution

Solution :

The given polar plot is a stable system and having type is one.

That means initial slope of magnitude plot is –20dB/dec.

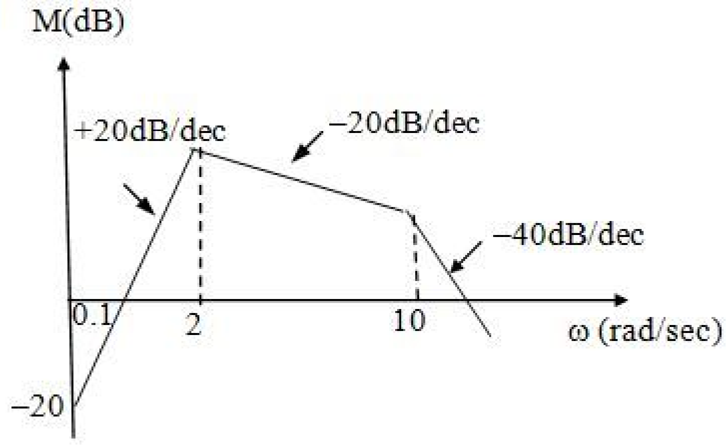
In option (A), $\omega_{PC} > \omega_{gc}$, the system is stable and having initial slope of –20dB/dec

Question No: 20

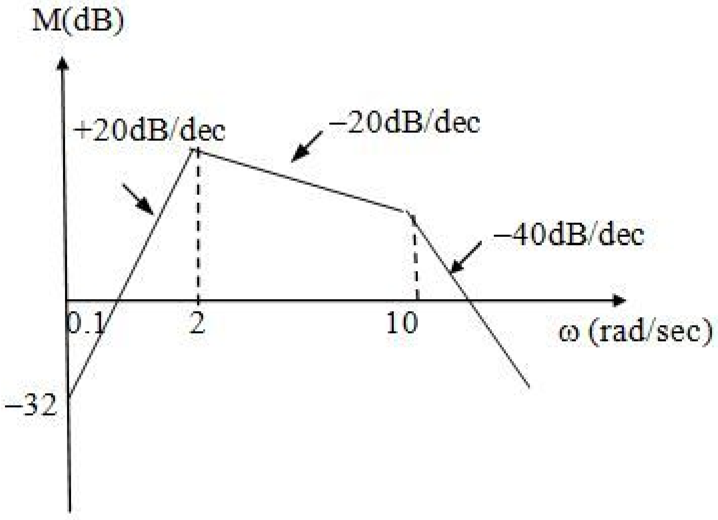
Analysis

The Bode magnitude plot of a system $G(s)H(s) = \frac{10se^{-2s}}{(s+2)^2(s+10)}$, is

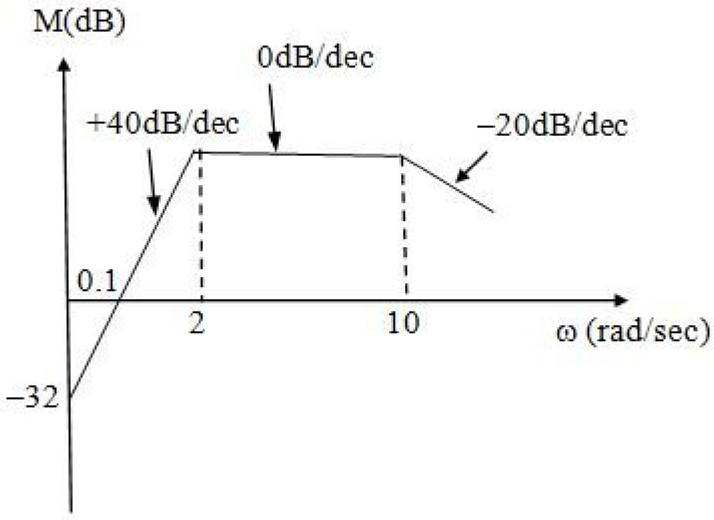
(A)



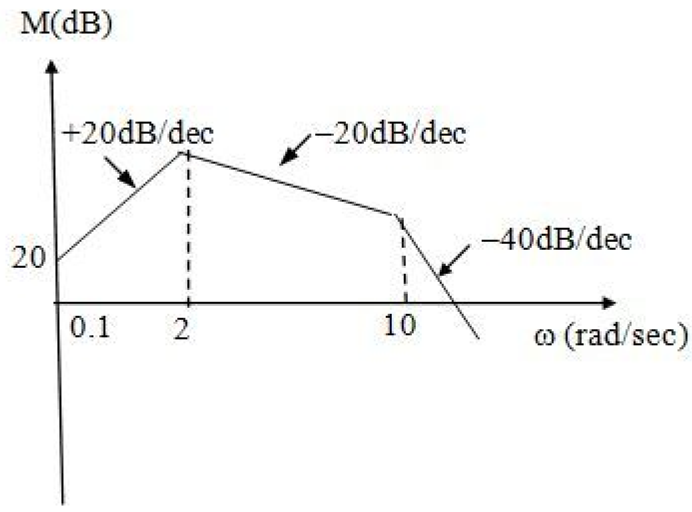
(B)



(C)



(D)



Not Attempted -- **Correct Answer : B**

Solution :

$$G(s)H(s) = \frac{10se^{-2s}}{2^2 \times 10\left(1+\frac{s}{2}\right)^2\left(1+\frac{s}{10}\right)} = \frac{0.25(s)e^{-2s}}{\left(1+\frac{s}{2}\right)^2\left(1+\frac{s}{10}\right)}$$

$M|_{\omega = 0.1} = 20 \log 0.25 + 20 \log 0.1 = -32$ dB

$\Rightarrow$ One zero at origin $\Rightarrow$ Initial slope is +20 dB/dec

At $\omega = 2$ rad/sec change in slope

$= (+20-40) = -20$ dB/dec

At $\omega = 10$ rad/sec change in slope $= (-20-20) = -40$ dB/dec

Question No: 21

Analysis

DFT of real sequence is given as

$X(k) = \{1, 2, a, b, 0, 1 -j, -2, c\}$. Then the value of a, b, c respectively

(A) 2, 1–j, –2

(B) 4, j, 1

(C) –2, 1+j, 2

(D) –1, 1+j, 2

Not Attempted -- Correct Answer : C

Video Solution

Solution :

We know that DFT of a real sequence has conjugate symmetry

i.e, $X(k) = X^*(N-K)$

Given N=8. $X(k) = X^*(8-K)$

$a = X(2) = X^*(8-2) = X^*(6) = -2$

$b = X(3) = X^*(8-3) = X^*(5) = 1 + j$

$c = X(7) = X^*(8-7) = X^*(1) = 2$

Question No: 22

Analysis

Let $x(n) = n^2 3^n u(n)$ and $x(n) \leftrightarrow X(z)$. If $Y(z) = \frac{z^2 - z^{-2}}{2} X(z)$.

Then y(n) value at n = 2 is _______.

Not Attempted -- Correct Answer : 648 & Valid Answer Range :648,648

Solution :

$$\text{Given } Y(z)=\frac{1}{2}z^{2}X(z)-\frac{1}{2}z^{-2}X(z)$$

$$y(n)=\frac{1}{2}x(n+2)-\frac{1}{2}x(n-2)$$

$$y(n)=\frac{1}{2}(n+2)^{2}3^{n+2}u(n+2)-\frac{1}{2}(n-2)^{2}3^{n-2}u(n-2)$$

$$y(2)=\frac{1}{2}(2+2)^{2}.3^{4}.1-\frac{1}{2}(2-2)^{2}.3^{(2-2)}.1$$

$$=\frac{1}{2}.16.81$$

$$=8\times 81$$

$$y(2)=648$$

Question No: 23

Analysis

An LTI system is described by the difference equation $y(n)-\frac{5}{6}y(n-1)+\frac{1}{6}y(n-2)=x(n)$. If system is unstable and anti-causal then impulse response of the system is given by

(A) $3\left(\frac{1}{2}\right)^{n}u(n-1)-2\left(\frac{1}{3}\right)^{n}u(-n-1)$

(B) $-3\left(\frac{1}{2}\right)^{n}u(-n-1)-2\left(\frac{1}{3}\right)^{n}u(-n-1)$

(C) $3\left(\frac{1}{2}\right)^{n}u(-n-1)+2\left(\frac{1}{3}\right)^{n}u(-n-1)$

(D) $-3\left(\frac{1}{2}\right)^{n}u(-n-1)+2\left(\frac{1}{3}\right)^{n}u(-n-1)$

Not Attempted -- Correct Answer : D

Video Solution

Solution :

Given $y(n)-\frac{5}{6}y(n-1)+\frac{1}{6}y(n-2)=x(n)$

Taking Z transform then

$$Y(z)-\frac{5}{6}z^{-1}Y(z)+\frac{1}{6}Y(z)z^{-2}=X(z)$$

$$\therefore \frac{Y(z)}{X(z)}=\frac{1}{1-\frac{5}{6}z^{-1}+\frac{1}{6}z^{-2}}$$

$$\therefore \frac{Y(z)}{X(z)}=\frac{3}{\left(1-\frac{1}{2}z^{-1}\right)}-\frac{2}{\left(1-\frac{1}{3}z^{-1}\right)}$$

Since H(z) is given as anti-causal and unstable. So, ROC is $\therefore |z|<\frac{1}{3}$

$$h(n)=-3\left(\frac{1}{2}\right)^{n}u(-n-1)+2\left(\frac{1}{3}\right)^{n}u(-n-1)$$

Question No: 24

Analysis

Consider $X(s)=\frac{\frac{1}{4}}{\left(s^2-\frac{s}{\sqrt{2}}+\frac{1}{4}\right)\left(s^2+\frac{s}{\sqrt{2}}+\frac{1}{4}\right)}$ then x(t) is

(A) real and even

(B) imaginary and even

(C) real and odd

(D) data insufficient

Not Attempted -- Correct Answer : A

Solution :

Given $X(s)=\frac{\frac{1}{4}}{\left(s^2-\frac{s}{\sqrt{2}}+\frac{1}{4}\right)\left(s^2+\frac{s}{\sqrt{2}}+\frac{1}{4}\right)}$

$$X(s)=\frac{\frac{1}{4}}{\left(s-\frac{1}{2}e^{j\frac{\pi}{4}}\right)\left(s-\frac{1}{2}e^{-j\frac{\pi}{4}}\right)\left(s+\frac{1}{2}e^{-j\frac{\pi}{4}}\right)\left(s+\frac{1}{2}e^{j\frac{\pi}{4}}\right)}$$

Since poles are in complex conjugate hence x(t) is real. Since poles are symmetric about $j\omega$ axis hence x(t) is even

Question No: 25

Analysis

Consider $H(s)=\dfrac{b[s^2+4s+3a]}{[s^2+3s+4b]}$.

Let x(t) is given as u(t) and y(0) = 2, y(∞) = 10.

Then $\left(\dfrac{a}{b}\right)$ is _______.

Not Attempted -- Correct Answer : 6.6 & Valid Answer Range :6.5,6.7

Video Solution

Solution :

$Y(s) = X(s)\, H(s)$

Given $x(t) = u(t) \Rightarrow X(s)=\dfrac{1}{s}$

$$Y(s)=\frac{1}{s}\frac{b[s^2+4s+3a]}{[s^2+3s+4b]}$$

Given y(0) = 2

From initial value theorem $y(0) = \underset{s\to\infty}{\text{Lt}}\ s\,Y(s) = 2$

$$\underset{s\to\infty}{\text{Lt}}\ \frac{s}{s}\frac{b[s^2+4s+3a]}{[s^2+3s+4b]}=2$$

$$\underset{s\to\infty}{\text{Lt}}\ \frac{bs^2\left[1+\frac{4}{s}+\frac{3a}{s^2}\right]}{s^2\left[1+\frac{3}{s}+\frac{4b}{s^2}\right]}=2$$

$b = 2$

Given y(∞) = 10

From final value theorem $y(\infty) = \underset{s\to 0}{\text{Lt}}\ sY(s) = 10$

$$\underset{s\to 0}{\text{Lt}}\ \frac{s}{s}\frac{b[s^2+4s+3a]}{[s^2+3s+4b]}=10$$

$$\frac{b.3a}{4b}=10$$

$$a=\frac{40}{3}$$

$$\frac{a}{b}=\frac{\frac{40}{3}}{2}=\frac{40}{6}=\frac{20}{3}=6.6$$

Question No: 26

Analysis

Consider a system with input x(t) and output y(t) related as follows

$$y(t) = \frac{d}{dt}\left\{e^{-t}x(t)\right\}.$$

Which one of the following statements is true?

(A) The system is nonlinear

(B) The system is time – invariant

(C) The system is stable

(D) The system has memory

Not Attempted -- Correct Answer : D

Solution :

Given the system, $y(t) = \frac{d}{dt}\left\{e^{-t}x(t)\right\}$

$$y(t) = e^{-t}\frac{d}{dt}[x(t)] + [-x(t)\,e^{-t}] = e^{-t}\left[\frac{d}{dt}x(t) - x(t)\right]$$

As y(t) is obtained from linear operations on x(t), the system is linear.

As the input x(t) is multiplied by a time varying function e^{-t}, the system is Time-varying.

For a bounded input x(t),

$$x(t) = u(t)$$

$$\Rightarrow y(t) = e^{-t}\delta(t) - e^{-t}u(t)$$

$$\Rightarrow y(t) = \delta(t) - e^{-t}u(t)$$

$\Rightarrow y(0) = \infty$ output is unbounded. Therefore the system is unstable.

As y(t) depends on $\frac{dx(t)}{dt}$, the system has memory.

Question No: 27

Analysis

The impulse response of a system is h (t) = tu(t). For an input u (t –1), the output is

(A) $\frac{t^2}{2}u(t)$

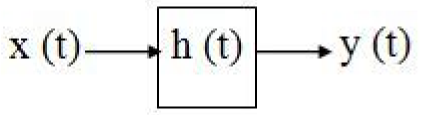
(B) $\frac{t(t-1)}{2}u(t-1)$

(C) $\frac{(t-1)^2}{2}u(t-1)$

(D) $\frac{t^2-1}{2}u(t-1)$

Not Attempted -- Correct Answer : C

Solution :



$y(t) = x(t) * h(t) = u(t-1) * t\,u(t)$

Apply laplace transform on both sides

$$Y(s) = \frac{e^{-s}}{s} \times \frac{1}{s^2} = \frac{e^{-s}}{s^3}$$

$$y(t) = \frac{1}{2}(t-1)^2 u(t-1)$$

Question No: 28

Analysis

Consider a discrete – time system for which the input x(n) and the output y(n) are related as $y(n) = x(n) - \frac{1}{3} y(n-1)$. If y(n) = 0 for n < 0 and x(n) = δ(n), then y(n) can be expressed in terms of the unit step u(n) as

(A) $\left(\frac{-1}{3}\right)^n u(n)$

(B) $\left(\frac{1}{3}\right)^n u(n)$

(C) $(3)^n u(n)$

(D) $(-3)^n u(n)$

Not Attempted -- Correct Answer : A

Solution :

Given $y(n) = x(n) - \frac{1}{3} y(n-1)$, and $y(n) = 0$, $n < 0$

$$y(n) + \frac{1}{3} y(n-1) = x(n)$$

Apply z-transform on both sides

$$Y(z)\left[1 + \frac{1}{3} z^{-1}\right] = X(z)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 + \frac{1}{3} z^{-1}} = \frac{z}{z + \frac{1}{3}}$$

For the given x(n) = δ(n), X(z) = 1

$$\therefore\ Y(z) = \frac{z}{z + \frac{1}{3}}$$

Use the standard Z.T pair:

$$a^n u(n) \longrightarrow \frac{z}{z-a}, |z| > |a|$$

$$y(n) = \left(-\frac{1}{3}\right)^n u(n),\ |z| > \frac{1}{3}$$

Question No: 29

Analysis

Let $f(x)$ be a real, periodic function satisfying $f(-x) = -f(x)$.

The general form of its Fourier series representation would be

(A) $f(x) = a_0 + \sum_{k=1}^{\infty} a_k \cos(kx)$

(B) $f(x) = \sum_{k=1}^{\infty} b_k \sin(kx)$

(C) $f(x) = a_0 + \sum_{k=1}^{\infty} a_{2k} \cos(kx)$

(D) $f(x) = \sum_{k=0}^{\infty} a_{2k+1} Cos(2k+1)x$

Not Attempted -- Correct Answer : B

Video Solution

Solution :

Given f(x) is a odd periodic function. So, cosine terms will be zero in trigonometric fourier series.

$$\therefore\ f(x) = \sum_{k=1}^{\infty} b_k \sin(kx)$$

Question No: 30

Analysis

A sinusoid x(*t*) of unknown frequency is sampled by an impulse train of period 20 ms. The resulting sample train is next applied to an ideal low pass filter with a cutoff at 25 Hz. The filter output is seen to be a sinusoid of frequency 20 Hz. This means that *x(t)* has a frequency of

(A) 10 Hz

(B) 60 Hz

(C) 30 Hz

(D) 90 Hz

Not Attempted -- Correct Answer : C

Solution :

Given $T_s = 20$ msec

$$f_s = \frac{1}{T_s} = \frac{1}{20\times10^{-3}} = \frac{1000}{20} = 50 \text{ Hz}$$

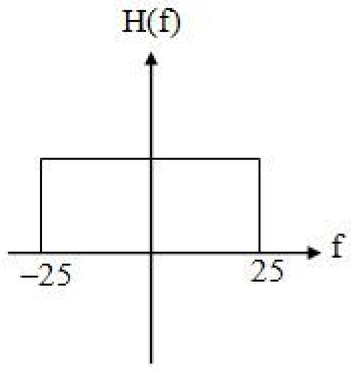
Assume the frequency of the input signal is 'f_m' then

$n = 0 \quad -f_m, f_m$

$n = 1 \quad f_s - f_m, f_s + f_m$

$n = 2 \quad 2f_s - f_m, 2f_s + f_m$

The above frequencies are passed through an ideal low pass filter with a cutoff at 25Hz as shown in figure.



Consider 'a' option $f_m = 10$ then output frequencies are

= 10, −10, 40, 60, 90, 110… Output is 10 Hz

Consider 'b' option: f_m= 60 Hz then output frequencies are = 60, −60, −10, 110, 40, 160 …… No output

Consider 'c' option: f_m = 30 Hz than output frequencies are = 30, −30, 20, 80, 70, 130…… The output of low pass filter = 20 Hz

Consider 'd' option: f_m = 90 Hz than output frequencies are = 90, −90, -40, 140, 190, 10…… The output of low pass filter = 10 Hz .

So, the right option is (C).