Bode Plot Questions

MCQ Question 1

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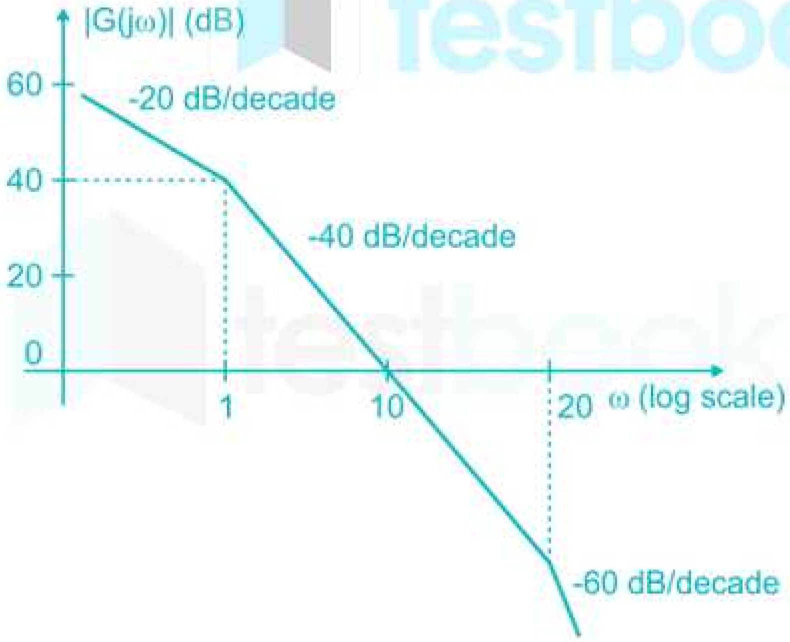
The asymptotic Bode magnitude plot of a minimum phase transfer function G(s) is shown below.



Consider the following two statements.
Statement I: Transfer function G(s) has three poles and one zero.
Statement II: At very high frequency (ω→∞), the phase angle $\angle G(j\omega) = -\frac{3\pi}{2}$.
Which one of the following options is correct?

1. Statement I is true and statement II is false.
2. Statement I is false and statement II is true.
3. Both the statements are true.

4. Both the statements are false.

Answer (Detailed Solution Below)

Option 2 : Statement I is false and statement II is true.

Bode Plot MCQ Question 1 Detailed Solution

Form the given bode plot, we can write the transfer function as follows

$$G\left(s\right)=\frac{k}{s(1+s)(1+\frac{s}{20})}$$

It has 3 poles and no zeros,

So, statement I is false

At ω → ∞, the phase angle

$$G\left(j\omega\right)=-\frac{\pi}{2}-\frac{\pi}{2}-\frac{\pi}{2}=-\frac{3\pi}{2}$$

So, statement II is true

MCQ Question 2

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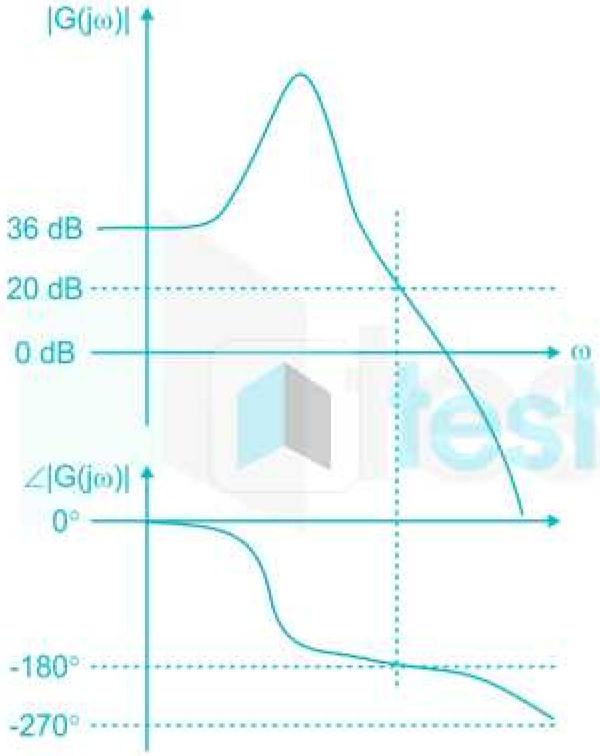
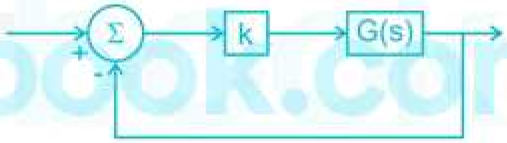
The figure below shows the Bode magnitude and phase plots of a stable transfer function $G(s) = \frac{n_0}{s^3 + d_2 s^2 + d_1 s + d_0}$





Consider the negative unity feedback configuration with gain in the feedforward path. The closed loop is stable for $k < k_0$. The maximum value of k_0 is ______.

Answer (Detailed Solution Below) **0.1**

Bode Plot MCQ Question 2 Detailed Solution

According to figure

Gain = 20 dB (at phase cross over frequency)

Gian margin = -20 dB

System make to marginally stable G.M = 0 or Gain = 0 dB

i.e 20 log K = -20

log K = -1

K = 10^{-1} = 0.1

So for K < 0.1 system will be stable

MCQ Question 3

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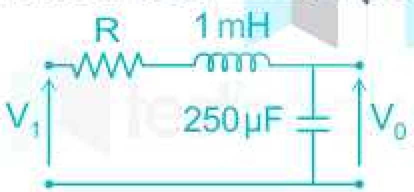
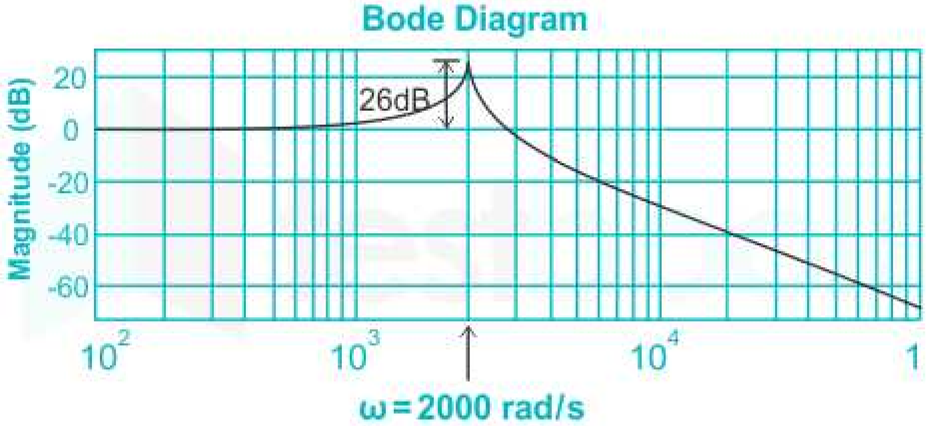
The bode magnitude plot for the transfer function $\frac{V_0(s)}{V_i(s)}$ of the circuit is as shown. The value of R is ______ Ω. (Round off to 2 decimal places.)





Answer (Detailed Solution Below) **0.09 - 0.11**

Bode Plot MCQ Question 3 Detailed Solution

Given circuit,

The transfer function for series RLC circuit by taking output voltage acroos the capacitor is given by,

$$T(s) = \frac{V_O(s)}{V_i(s)} = \frac{1}{LCs^2 + RCs + 1}$$

Put, s = jω

$$\frac{V_O(s)}{V_i(s)} = \frac{1}{-\omega^2 LC + j\omega RC + 1}$$

$$\frac{V_O(s)}{V_i(s)} = \frac{1}{-(2000^2 \times 1m \times 250\mu) + j(250\mu)R + 1}$$

$$\frac{V_O(s)}{V_i(s)} = \frac{1}{0.5R}$$

From the plot,

20 log$|M_r|$ = 26 dB

$|M_r|$ = 19.95

19.95 × 0.5R = 1

R = 0.1 Ω

Alternate Method

Resonant Peak formula,

$$M_r = \frac{1}{2\zeta\sqrt{1-\zeta^2}}$$

M_r = 19.95

ζ = 0.025

For RLC series circuit,

$$\zeta = \frac{R}{2}\sqrt{\frac{C}{L}}$$

$$0.025 = \frac{R}{2}\sqrt{\frac{250\mu}{1m}}$$

R = 0.1 Ω

MCQ Question 4

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When the gain margin is positive and phase margin is negative, the system is:

1. unstable
2. highly stable
3. oscillatory
4. stable

Answer (Detailed Solution Below)

Option 1 : unstable

Bode Plot MCQ Question 4 Detailed Solution

Phase Cross over Frequency:

- The frequency at which the phase plot is having the phase of -180° is known as phase cross-over frequency.
- It is denoted ω_{pc} .
- The unit of phase cross over frequency is rad/sec

Gain Cross over Frequency:

- The frequency at which the magnitude plot is having the magnitude of zero dB is known as gain cross over frequency.
- It is denoted by ω_{gc}.
- The unit of gain cross over frequency is rad/sec

Gain Margin:

Gain margin GM is defined as the negative of the magnitude in dB, at phase cross over frequency, i.e.

$$GM = 20\log\left(\frac{1}{M_{pc}}\right) = 20\log M_{pc}$$

M_{pc} is the magnitude at phase cross over frequency. The unit of gain margin (GM) is dB.

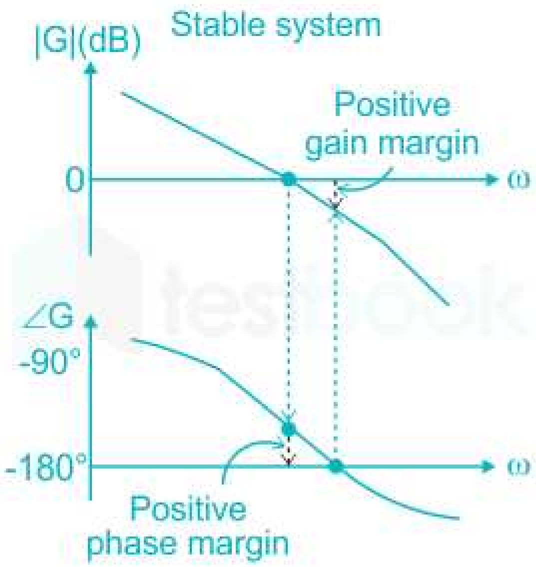
Phase Margin

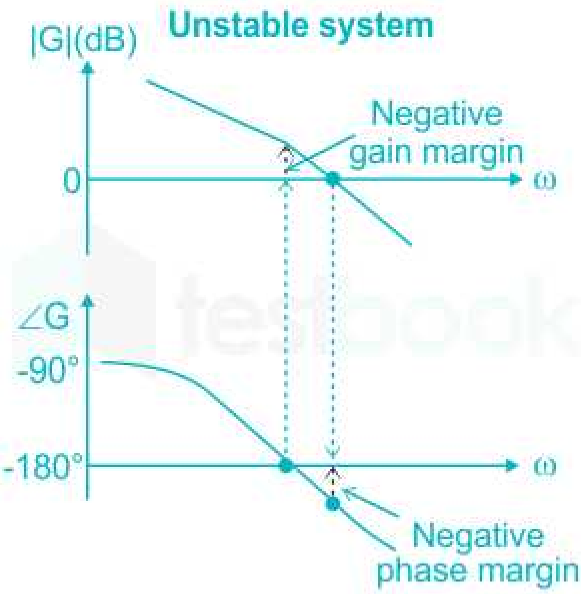
The phase margin of a system is defined as:

PM = 180° + ϕ_{gc}

The stability of the control system is based on the relation between gain margin and phase margin as:

Gain Margin (GM)	Phase Margin (PM)	Nature
Positive	Positive	Stable
Zero	Zero	Marginally Stable
Negative	Negative	Unstable
Positive	**Negative**	**Untable**





MCQ Question 5 View this Question Online >

The transfer function of a system is $\frac{10(1+0.2s)}{(1+0.5s)}$

The corner frequencies will be

1. -0.2 and -0.5
2. 5 and 2
3. -5 and -2
4. 0.2 and 0.5

Answer (Detailed Solution Below)

Option 2 : 5 and 2

Bode Plot MCQ Question 5 Detailed Solution

Concept:

Bode plot transfer function is represented in standard time constant form as

$$T\left(s\right)=\frac{k\left(\frac{s}{\omega_{c_1}}+1\right)\ldots}{\left(\frac{s}{\omega_{c_2}}+1\right)\left(\frac{s}{\omega_{c_3}}+1\right)\ldots}$$

ω_{c1}, ω_{c2}, ... are corner frequencies.

In a Bode magnitude plot,

- For a pole at the origin, the initial slope is -20 dB/decade
- For a zero at the origin, the initial slope is 20 dB/decade

- The slope of magnitude plot changes at each corner frequency
- The corner frequency associated with poles causes a slope of -20 dB/decade
- The corner frequency associated with poles causes a slope of -20 dB/decade
- The final slope of Bode magnitude plot = (Z − P) × 20 dB/decade

Where Z is the number zeros and P is the number of poles

Application:

The given transfer function is $\frac{10(1+0.2s)}{(1+0.5s)}$

$$= \frac{10\left(1+\frac{s}{5}\right)}{\left(1+\frac{s}{2}\right)}$$

By comparing with the standard transfer function, corner frequencies are

$\omega_1 = 2$, $\omega_2 = 5$

MCQ Question 6

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Slope of the asymptote in Bode plot for a second-order system is:

1. 18 dB per octave
2. 6 dB per octave
3. 3 dB per octave
4. 12 dB per octave

Answer (Detailed Solution Below)

Option 4 : 12 dB per octave

Bode Plot MCQ Question 6 Detailed Solution

Concept:

Bode plot transfer function is represented in standard time constant form as

$$T(s) = \frac{k\left(\frac{s}{\omega_{c1}}+1\right)\dots}{\left(\frac{s}{\omega_{c2}}+1\right)\left(\frac{s}{\omega_{c3}}+1\right)\dots}$$

ω_{c1}, ω_{c2}, ... are corner frequencies.

In a Bode magnitude plot,

- For a pole at the origin, the initial slope is -20 dB/decade
- For a zero at the origin, the initial slope is 20 dB/decade
- The slope of magnitude plot changes at each corner frequency
- The corner frequency associated with poles causes a slope of -20 dB/decade
- The corner frequency associated with poles causes a slope of -20 dB/decade
- The final slope of Bode magnitude plot = (Z − P) × 20 dB/decade

Where Z is the number zeros and P is the number of poles

Application:

The given system is second order system. So, the number of poles is 2.

The slope of the asymptote = 2 × 20 dB/decade = 40 dB/decade

20 bB/decade = 6 dB/octave

Therefore, the slope of the asymptote = 12 dB/octave

MCQ Question 7

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A system is ______ when gain margin is positive whereas the phase margin is negative.

1. Stable
2. Unstable

3. Probabilistic

4. Undetermined

Answer (Detailed Solution Below)

Option 2 : Unstable

Bode Plot MCQ Question 7 Detailed Solution

Phase Cross over Frequency:

- The frequency at which the phase plot is having the phase of -180° is known as phase cross-over frequency.
- It is denoted ω_{pc} .
- The unit of phase cross over frequency is rad/sec

Gain Cross over Frequency:

- The frequency at which the magnitude plot is having the magnitude of zero dB is known as gain cross over frequency.
- It is denoted by ω_{gc}.
- The unit of gain cross over frequency is rad/sec

Gain Margin:

Gain margin GM is defined as the negative of the magnitude in dB, at phase cross over frequency, i.e.

$$GM = 20\log\left(\frac{1}{M_{pc}}\right) = 20\log M_{pc}$$

M_{pc} is the magnitude at phase cross over frequency. The unit of gain margin (GM) is dB.

Phase Margin

The phase margin of a system is defined as:

PM = 180° + ϕ_{gc}

The stability of the control system is based on the relation between gain margin and phase margin as:

Gain Margin (GM)	Phase Margin (PM)	Nature
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Negative	Negative	Unstable
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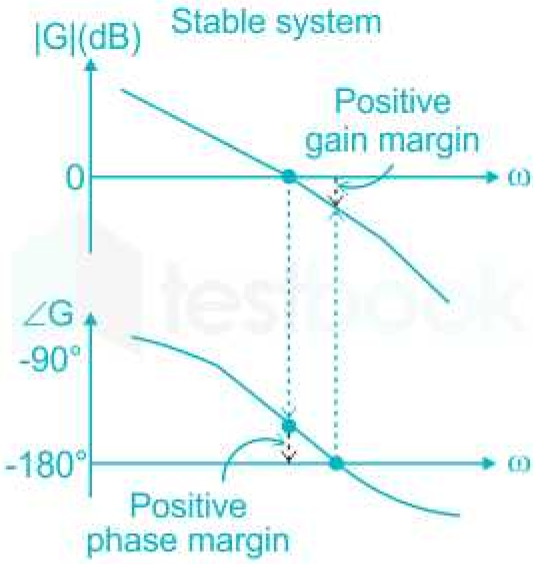

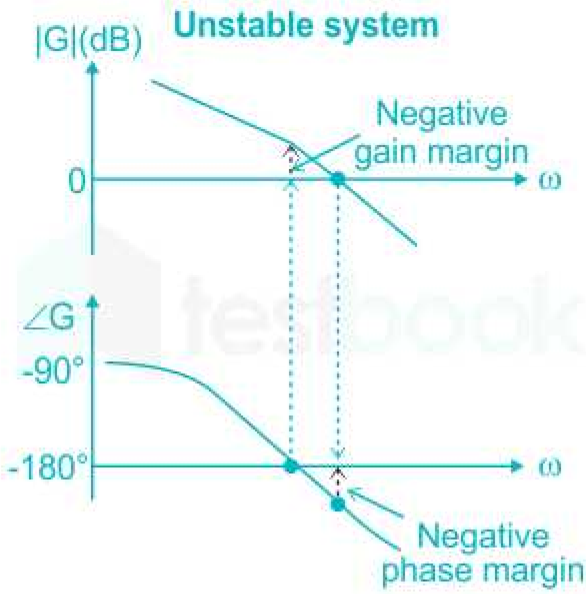

MCQ Question 8

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An op-amp based programmable gain amplifier with a negative feedback is designed, An op-amp based programmable gain amplifier with a negative feedback is designed. Which method will be the best suitable for the stability analysis?

1. Bode Plot
2. Nyquist Plot
3. Root Locus
4. R-H Stability Criteria

Answer (Detailed Solution Below)

Option 1 : Bode Plot

Bode Plot MCQ Question 8 Detailed Solution

Concept-

Stability can be determined easily from a plot of the loop gain versus frequency.

The critical point is when the loop gain equals 0 dB (gain equals 1) because a circuit must have gain ≥ 1 to become unstable.

The phase margin, which is the difference between the measured phase angle and 180°, is calculated at the 0-dB point.

Bode plot is the plot of loop gain versus frequency.

Using Bode Plot we can easily find the gain margin and phase margin of the system.

We can also see the effect of resistor or capacitance on the Bode plot by analyzing the Bode plot.

We can get different parameters like Bandwidth, the cutoff frequency of op-amp by bode plot So the Bode plot is the best suitable for stability analysis.

MCQ Question 9

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Bode plot is applicable for -

1. Minimum phase network
2. Non-minimum phase network
3. All pass network
4. Every network of the control system

Answer (Detailed Solution Below)

Option 1 : Minimum phase network

Bode Plot MCQ Question 9 Detailed Solution

Bode plot:

- In electrical engineering and control theory, a Bode plot is a graph of the frequency response of a system. It is usually a combination of a Bode magnitude plot, expressing the magnitude (usually in decibels) of the frequency response, and a Bode phase plot, expressing the phase shift.
- The Bode magnitude plot is the graph of the function $|H(s = j\omega)|$ of frequency ω (with j being the imaginary unit). The ω -axis of the magnitude plot is logarithmic and the magnitude is given in decibels, i.e., a value for the magnitude $|H|$ is plotted on the axis at $20\log10|H|$
- The Bode phase plot is the graph of the phase, commonly expressed in degrees, of the transfer function $H(s = j\omega)$ as a function of ω . The phase is plotted on the same logarithmic ω-axis as the magnitude plot, but the value for the phase is plotted on a linear vertical axis.
- For many practical problems, the detailed Bode plots can be approximated with straight-line segments that are asymptotes of the precise response. Hence Bode plot as asymptotic plot.
- Bode plot is applicable for **minimum phase system.**

Minimum Phase system:

- A transfer function G(s) is **minimum phase if both G(s) and 1/G(s) are causal and stable**
- A minimum phase system does not have zeros or poles on the right-half plane and it does not have delay.
- Bode discovered that the phase can be uniquely derived from the slope of the magnitude for minimum-phase system.
- We can draw Bode plot for non-minimum phase systems, but the magnitude and phase-angle plots are not 'uniquely related'.
- For a Minimum phase system, the magnitude and phase-angle plots are uniquely related, that means if either one of them is specified over the entire frequency range, the other plot can be determined uniquely. This does not apply to NMP systems.

Additional Information

All pass systems:

All pass systems:

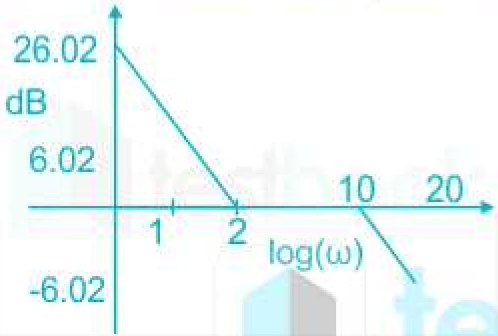
An all-pass system is a system whose frequency response magnitude is constant for all frequencies.

Non-minimum phase network:

A system is said to be Non-minimum phase system if all the open loop poles and zeros are lies in right- half plane.

MCQ Question 10 View this Question Online >

If the given system is connected to a unity negative feedback system, the steady-state error of a closed-loop system to a ramp input is;



1. 0.01
2. 1
3. 0.5
4. 0.2

Answer (Detailed Solution Below)

Option 3 : 0.5