بسم الله الرحمن الرحيم

Automatic Control
MENG366
Third Exam

Closed Book Exam
Time 1 ½ hrs
Wednesday: 23/10/1424 H

Student Name:			Sec. No.:	ID No.:
Q1: /10	Q2: /10	Q3: /10	Q4: /10	Total: /40

1. The feedforward transfer function, $G(s)$ of the unity feedback system shown in Fig.1a is represented in frequency domain by the asymptotic Bode diagram shown in Fig.1b.
   a) Find the open-loop transfer function of the system, $G(s)$.
   b) Find the closed-loop transfer function of the system, $C(s)/R(s)$.
   c) Find the response of this system to a unit step input (i.e. $R(s) = 1/s$).
   d) Sketch the response, $c(t)$, of the system.

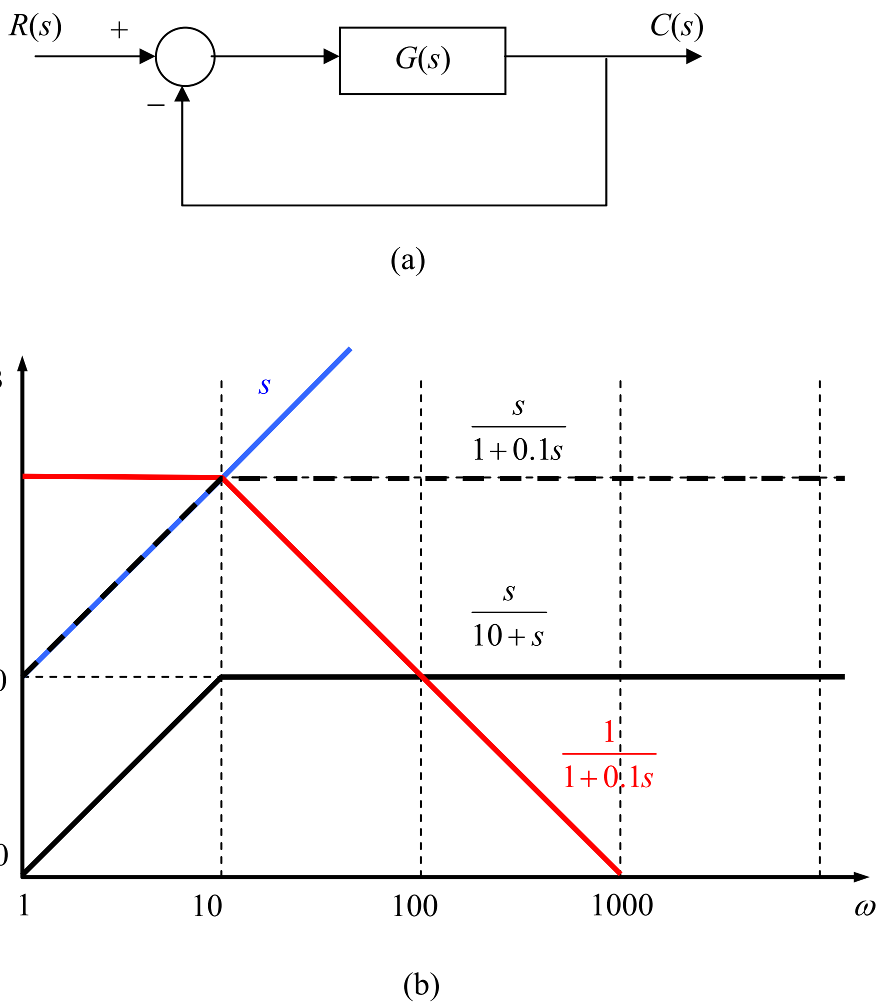


Fig.1

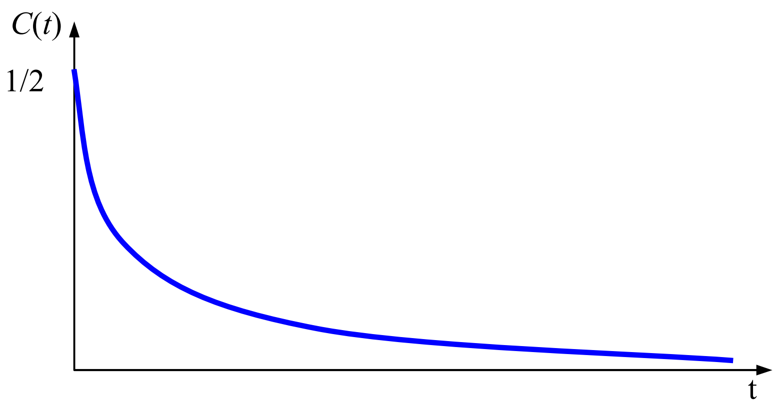
Answer:

a) The open-loop transfer function is: $G(s) = \dfrac{s}{10+s}$

b) The closed-loop transfer function is: $\dfrac{G(s)}{1+G(s)} = \dfrac{\dfrac{s}{10+s}}{1+\dfrac{s}{10+s}} = \dfrac{s}{10+2s}$.

c) The unit step response of this system is: $C(s) = \dfrac{1}{10+2s}$ and $c(t) = \dfrac{1}{2}e^{-5t}$.

d)



2. Consider the unity-feedback system with the following $G(s)$:

$$G(s) = \frac{1}{s+1}$$

a) Calculate the magnitude and phase of $G(s)$ for ω=0.1, 0.2, 0.5, 1, 2, 5, and 10 rad/sec.
b) Sketch the asymptotic Bode plots for $G(s)$.
c) Sketch the Nyquist plot for $G(s)$.
d) From the Bode plots, determine the magnitude and the phase of $G(s)$ for ω=0.1, 0.2, 0.5, 1, 2, 5, and 10 rad/sec.
e) On the Nyquist plot, locate $G(s)$ for ω=0.1, 0.2, 0.5, 1, 2, 5, and 10 rad/sec.
f) Comment on your results.

Answer:

a)

$$G(j\omega) = \frac{1}{j\omega+1}$$

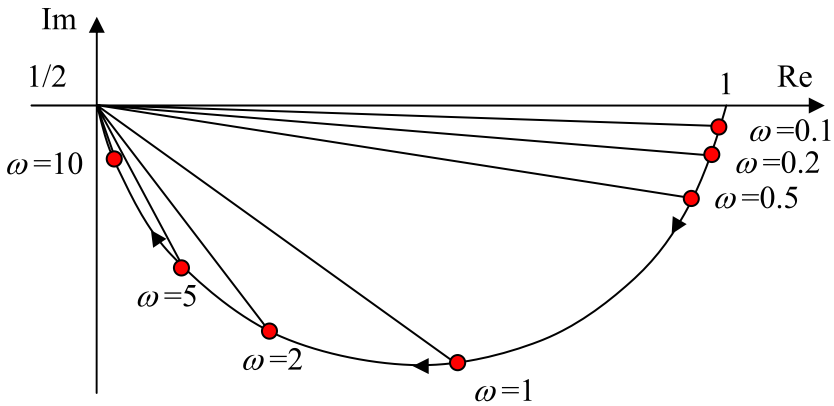
$$|G(j\omega)| = \frac{1}{\sqrt{\omega^2+1}}$$

$$\underline{|G(j\omega)} = -\tan^{-1}(\omega)$$

ω	$\lvert G(j\omega)\rvert$		$\underline{\lvert G(j\omega)}$
	Linear	dB	Degree
0.1	0.995	-0.0432	-5.7106
0.2	0.981	-0.1703	-11.3099
0.5	0.894	-0.9691	-26.5651
1	0.707	-3.0103	-45
2	0.447	-6.9897	-63.4349
5	0.196	-14.1497	-78.6901
10	0.1	-20.0432	-84.2894

b) See Fig.2

c) and e)



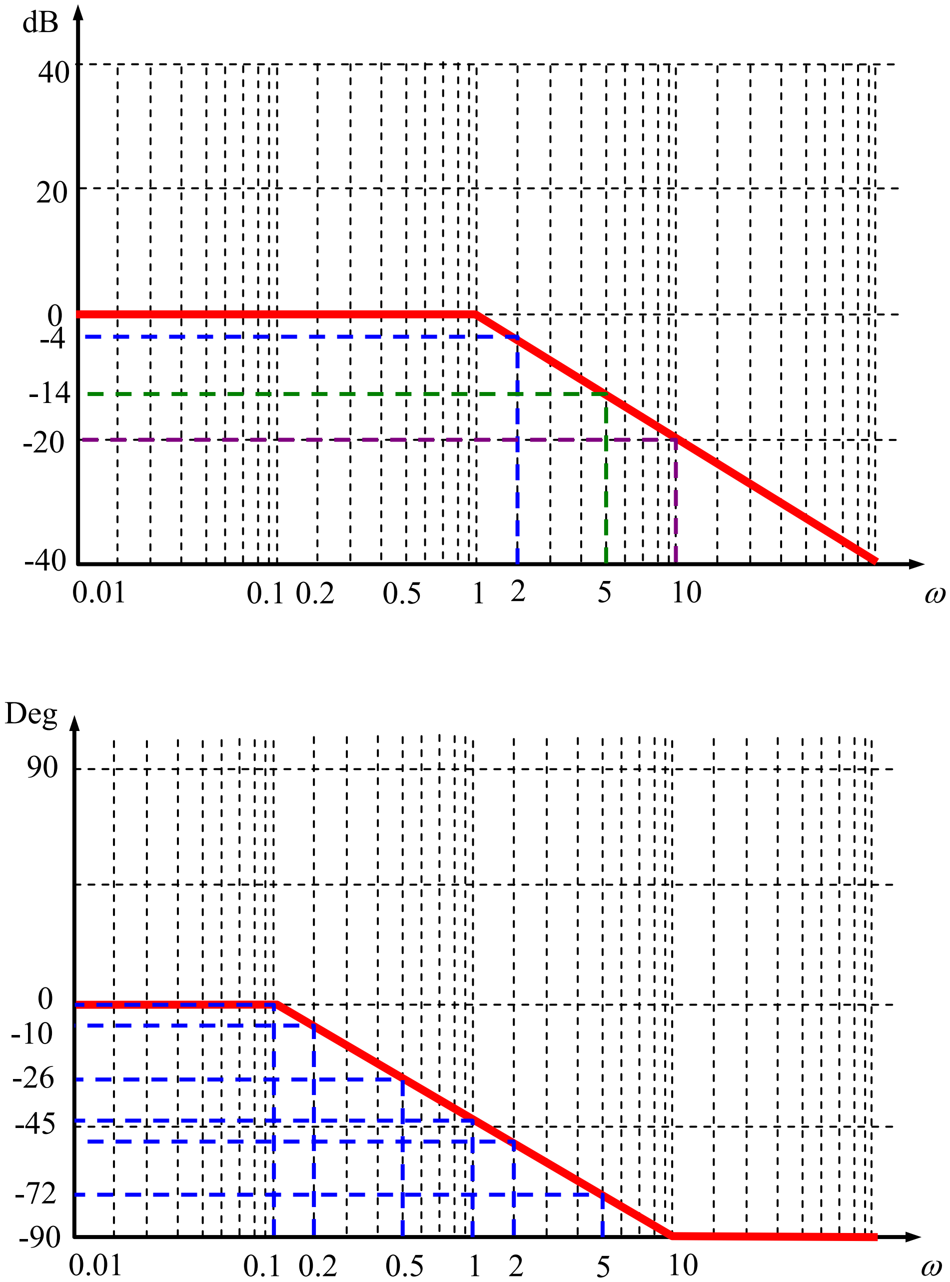

dB
40
20
0
-4
-14
-20
-40
0.01
0.1
0.2
0.5
1
2
5
10
ω
Deg
90
0
-10
-26
-45
-72
-90
0.01
0.1
0.2
0.5
1
2
5
10
ω

Fig.2

3. Consider the following transfer function:

$$G(s) = \frac{1000(s+0.5)}{s(s+10)(s+50)}$$

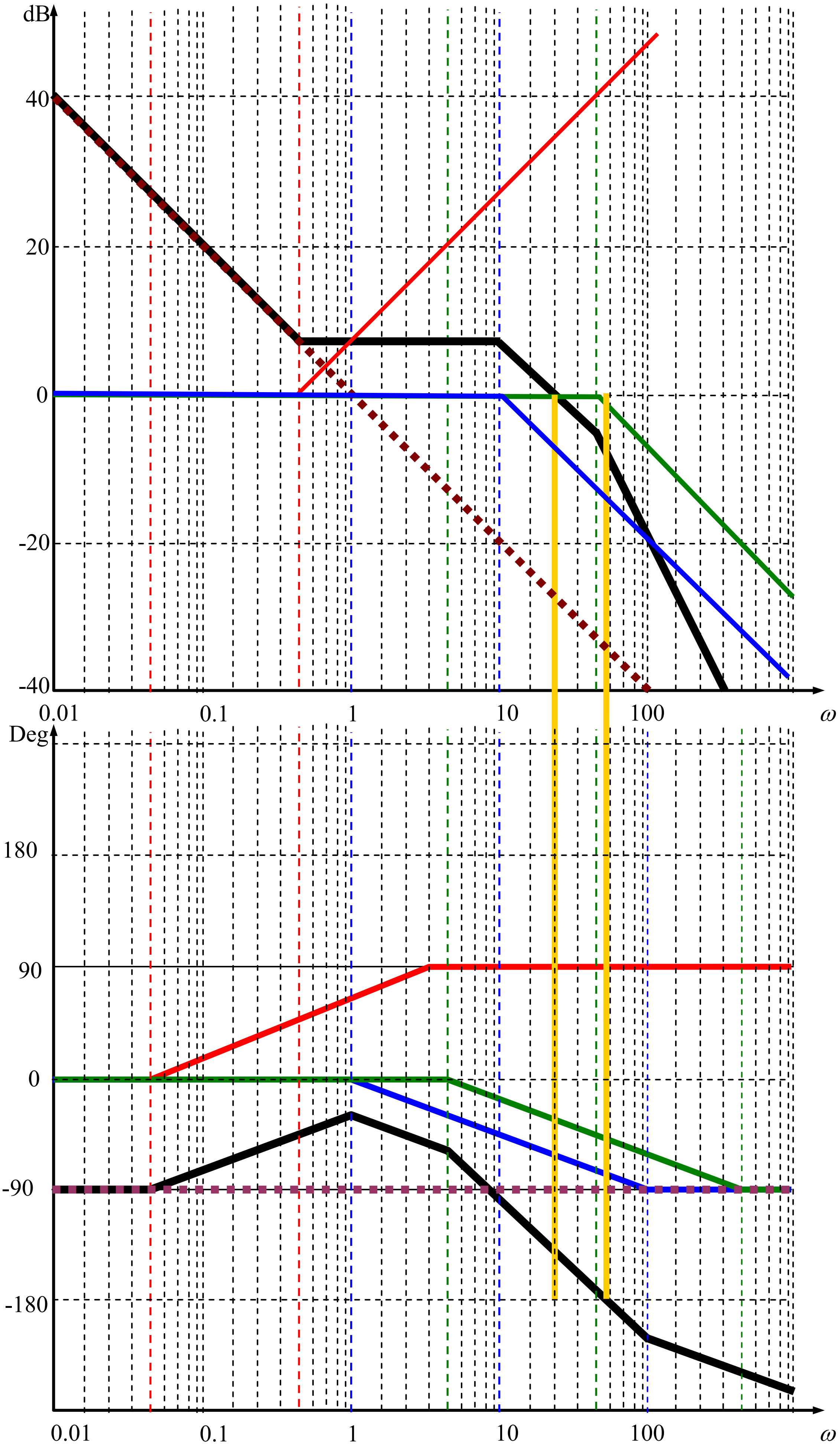
a) Plot the Bode magnitude and phase for the system.
b) Find the gain margin and the phase margin of the system.
c) Is the system stable? Why?

Answer:

$$G(s) = \frac{1000\left(\frac{1}{2}\right)(2s+1)}{(10)s(0.1s+1)(50)(0.02s+1)}$$

$$G(s) = \frac{(2s+1)}{s(0.1s+1)(0.02s+1)}$$

From the Bode plot, the system is stable and the gain margin is +7.5 dB and the phase margin is +40 deg.


dB
40
20
0
-20
-40
0.01
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1
10
100
ω
Deg
180
90
0
-90
-180
0.01
0.1
1
10
100
ω

4. Consider the unity-feedback control system having the following open-loop transfer function:

$$G(s)H(s) = \frac{K(s+3)}{s(s-1)} \qquad (K > 1)$$

The Nyquist plot (polar plot) of the open-loop frequency response is shown in Fig.4. Investigate the stability of the closed-loop system.

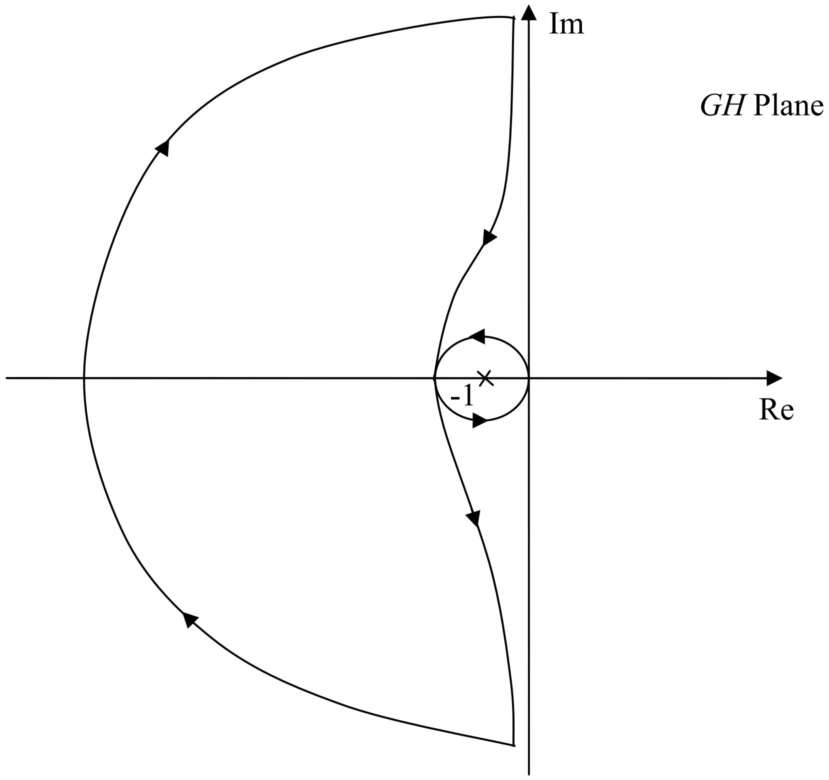

Fig.4

Answer:

The open-loop transfer function has one unstable pole, or P=1.
The Nyquist plot shown in Fig.4 indicates that the -1+0j point is encircled by the $G(s)H(s)$ locus once in the tawafwise direction. Therefore, N=-1.
Hence, $N+P=0$ which means that there is no closed-loop pole lies in the right-half s plane and the closed-loop system is STABLE.

مع دعواتنا لكم بالتوفيق

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