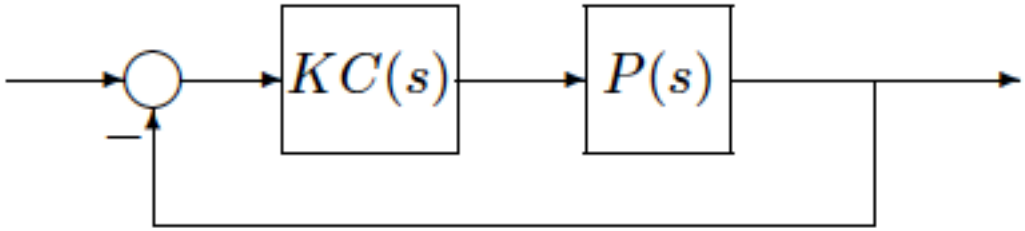
# Classical Control
# Homework 5 – 20% of your final score

Assigned 2020.07.17
Submission deadline 2020.08.07
(ZERO point for late submission)

Your answers can be English or Japanese

# Problem 1

Consider the feedback system.

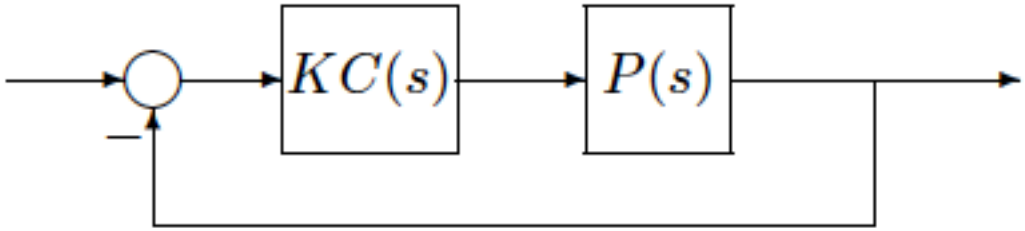



Let $P(s) = \frac{4s^2+1}{s(s-1)^2}$ and $C(s) = 1$.

Draw by hand the Nyquist plot of $P(s)C(s)$.
How many encirclements of the point $-\frac{1}{K}$ and in what direction are required for feedback stability? What ranges of gain $K$ are required for feedback stability? Explain all your answers.

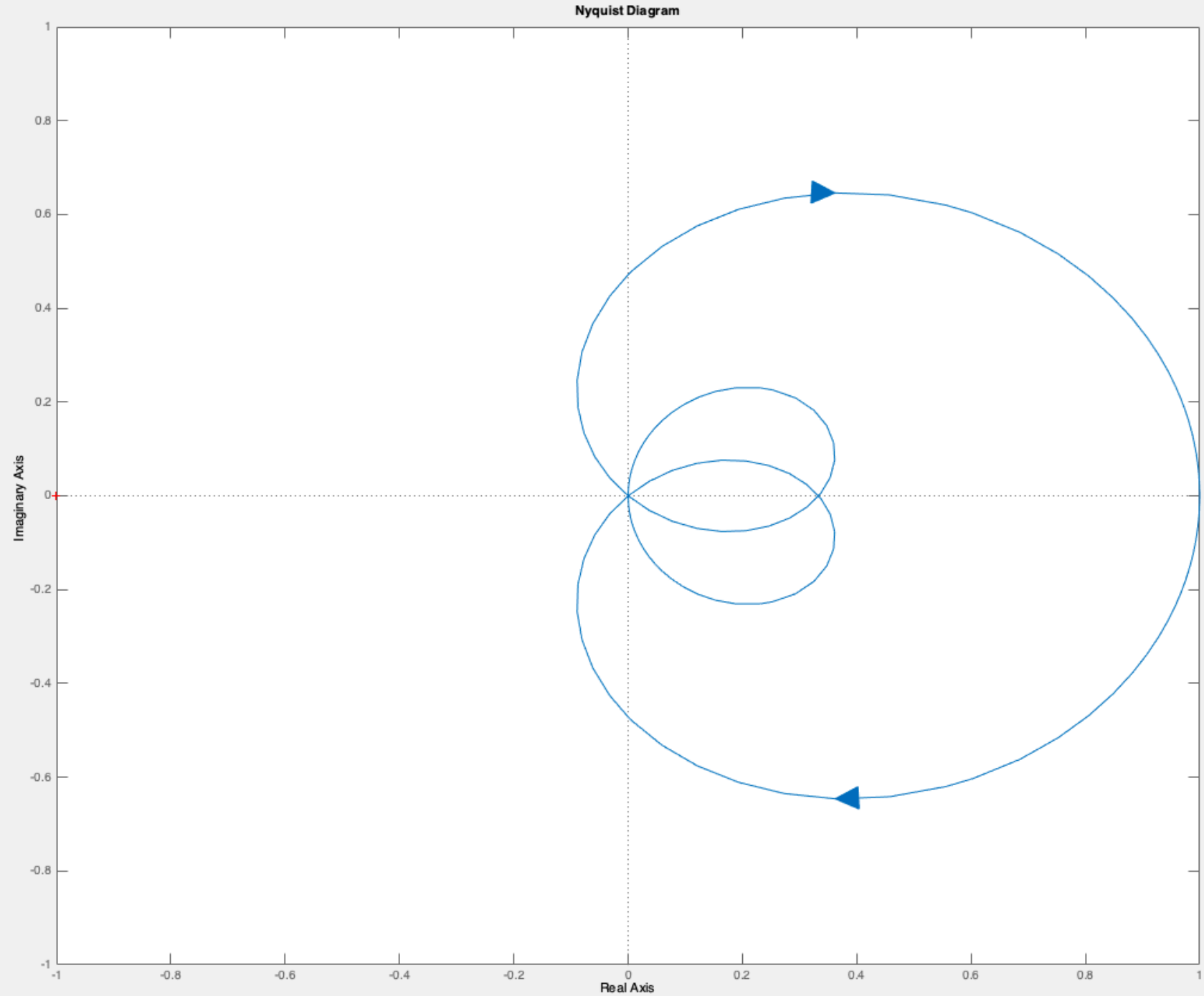
# Problem 2

Consider the feedback system.




Let $P(s) = \frac{s^2+1}{(s+1)(s^2+s+1)}$, $C(s) = 1$, and $K = 1$.

The Nyquist plot of $P(s)C(s)$ by Matlab
is shown on the next slide.
Is the feedback system stable by Nyquist criterion?
Explain why or why not.
If stable, find from the Nyquist plot the phase margin,
gain margin, and stability margin.


Nyquist Diagram
Imaginary Axis
Real Axis
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

# Problem 3

Consider the transfer function

$$G(s) = \frac{s+5}{s(s-1)(s^2-1)}$$

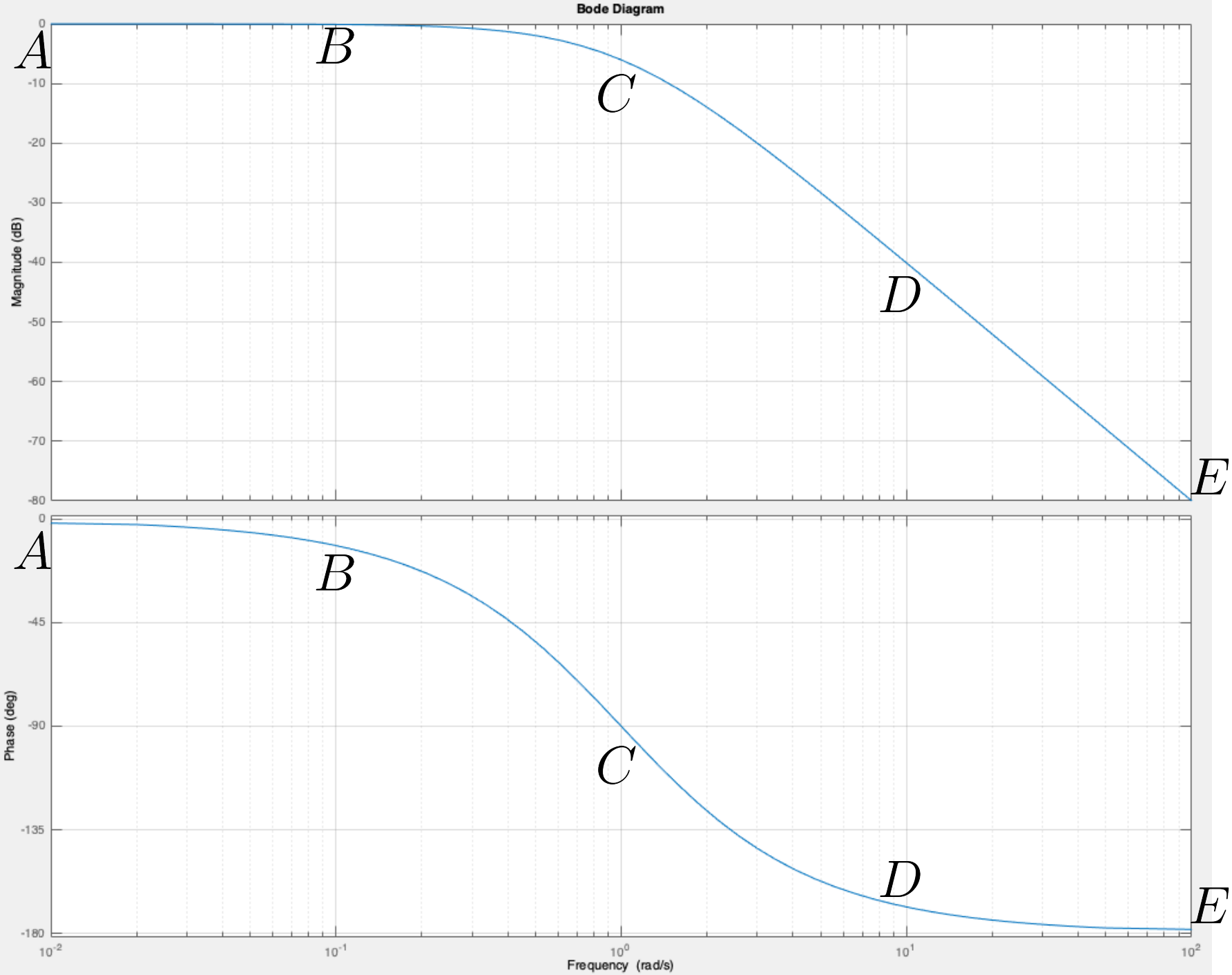
Draw by hand the Bode plots of $G(s)$.
In the plots, you should clearly write down
the key frequencies, magnititudes, and phases.

# Problem 4

The Bode plots of a transfer function $G(s)$ are shown on the next slide.

Draw by hand the Nyquist plot of this $G(s)$.

Hint: consider how to map the points $A, B, C, D, E$ (of frequencies $0, 0.1, 1, 10, \infty$) on the Bode plots to the Nyquist plot.


Bode Diagram
Magnitude (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
A
B
C
D
E
Phase (deg)
0
-45
-90
-135
-180
A
B
C
D
E
$10^{-2}$
$10^{-1}$
$10^{0}$
$10^{1}$
$10^{2}$
Frequency (rad/s)