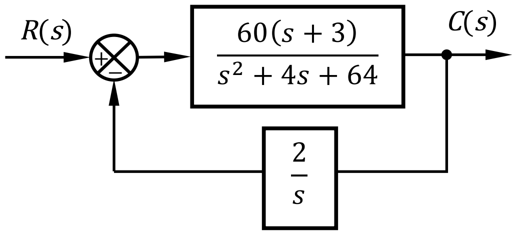
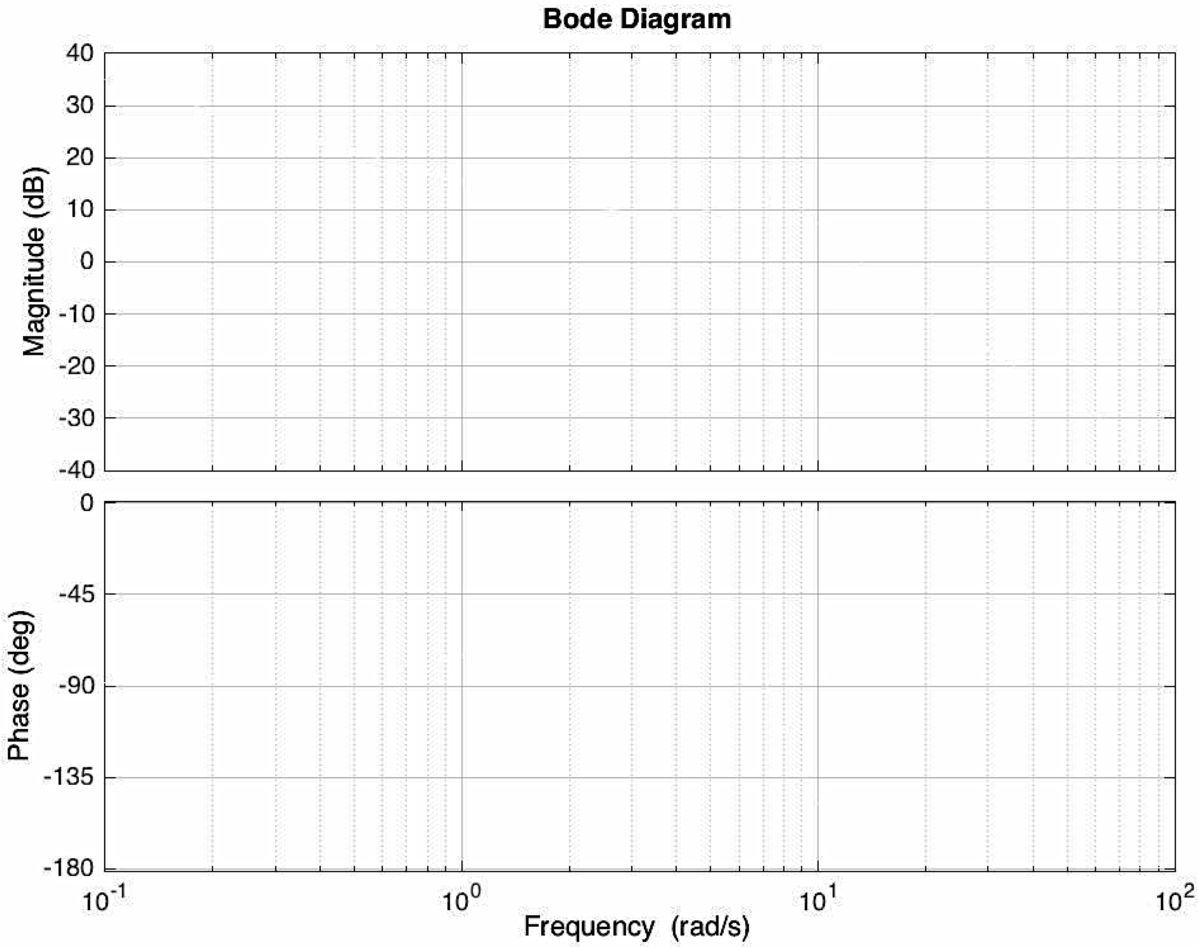
YTU ELECTRICAL & ELECTRONICS FACULTY
DEPARTMENT OF CONTROL & AUTOMATION ENGINEERING
KOM3712 CONTROL SYSTEM DESIGN, Midterm Exam

Name and Surname:	**Grades:**
Student number:	**Problem-1.** 20
Signature: **Date:** April 10, 2019	**Problem-2.** 30
Duration: 80 mins.	**Problem-3.** 30
	Problem-4. 20

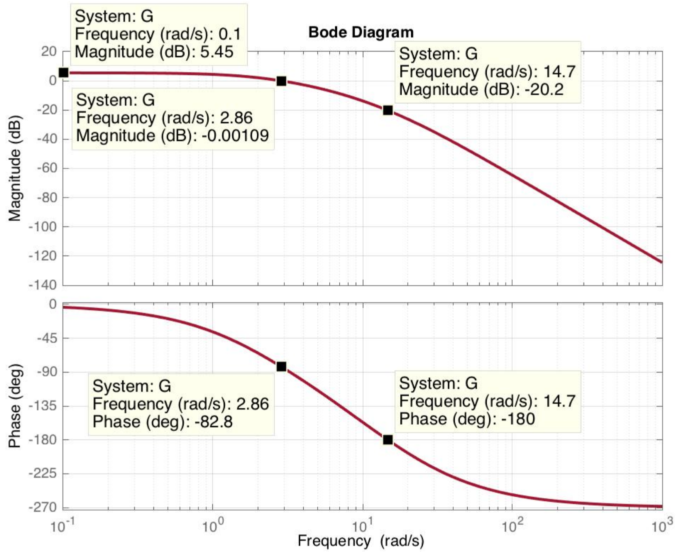
Problem-1. Considering the feedback system on the right,



- **(a)** Sketch the Bode magnitude and phase plots with asymptotes on the logarithmic planes provided.
- **(b)** Write the slopes of each asymptotes on the plots.
- **(c)** Calculate the correction value in dB and show it on the magnitude plot for the underdamped components.



Problem-2. For the Bode plots on the right, which were obtained experimentally from a subsystem $G(s)$ for the gain K=600,



- **(a)** Determine the Gain Margin in dB,
- **(b)** and Phase Margin in degrees when it is connected to a feedback system.
- **(c)** What is the value of gain, K_{cr}, that makes the system marginally stable?
- **(d)** What would be the period of oscillation, T_{cr}, in sec at this gain?
- **(e)** Write the range of gain K to keep the system stable.
- **(f)** Determine the system type then find the appropriate static error constant and the corresponding steady state error.

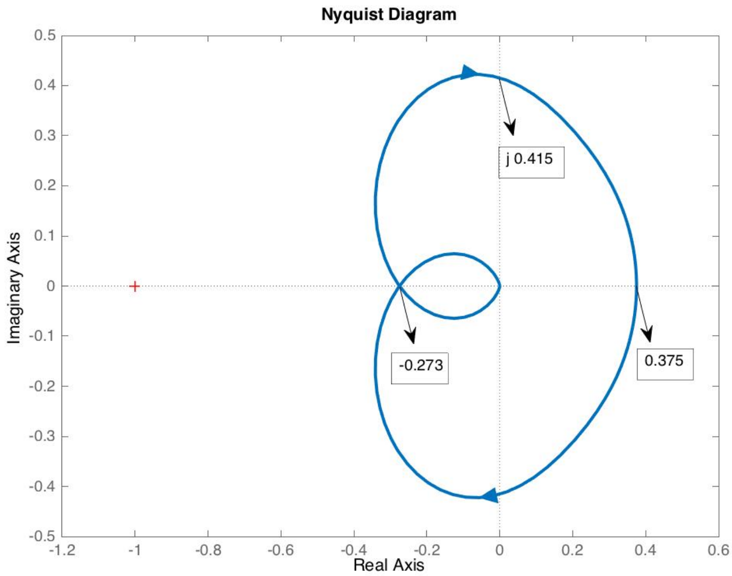
Problem-3. Suppose that the Nyquist diagram on the right is for a stable open-loop transfer function of a feed-back control system when the gain is K=120. For the feedback system,

(a) Find the range of gain K for stability using the Nyquist criterion.

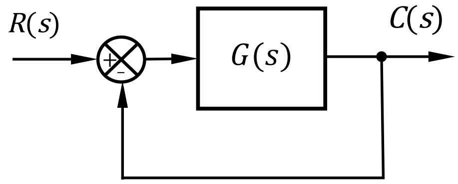
(b) Find the Gain Margin in dB.

(c) What would be value of gain to get a gain margin of 20 dB?

(d) What would be the real-axis crossing values of the Nyquist plot at that gain?



Problem-4. Considering the unity feedback system on the RHS, where the open-loop transfer function is,



$$G(s) = \frac{200{,}000}{s(s+40)(s+100)}$$

$G(s)$ has the following Bode plots. As the phase margin has a low value ($29°$), the system produces a very high percent overshoot (over 40%). Determine the value of gain, *K*, to increase the phase margin to 50° so that the closed-loop step response can produce below 20% overshoot ($\zeta = 0.48$).