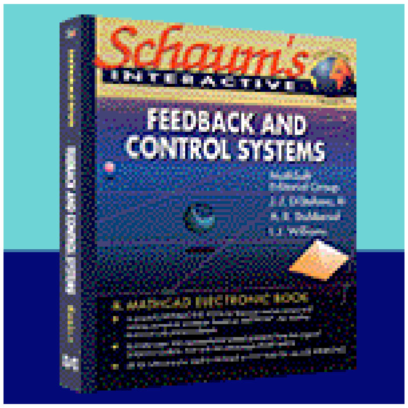
Schaums Interactive Outline Series:

Feedback and Control Systems



Platform: Windows
Includes the Mathcad Engine; requires 4 MB hard disk space
Available for ground shipment

Through more than 100 solved problems in control system design and analysis, several major techniques of analysis and design are developed and demonstrated. For students and educators, this Electronic Book is an excellent tool for exploring and understanding the fundamentals of feedback control systems. Professionals get advanced numerical and symbolic techniques for plotting system behavior and solving for stability and design specifications. The early chapters develop the theoretical foundations while later sections apply this understanding to designing feedback control systems. Plus the Mathcad Engine is built-in so the math is "live" and interactive.

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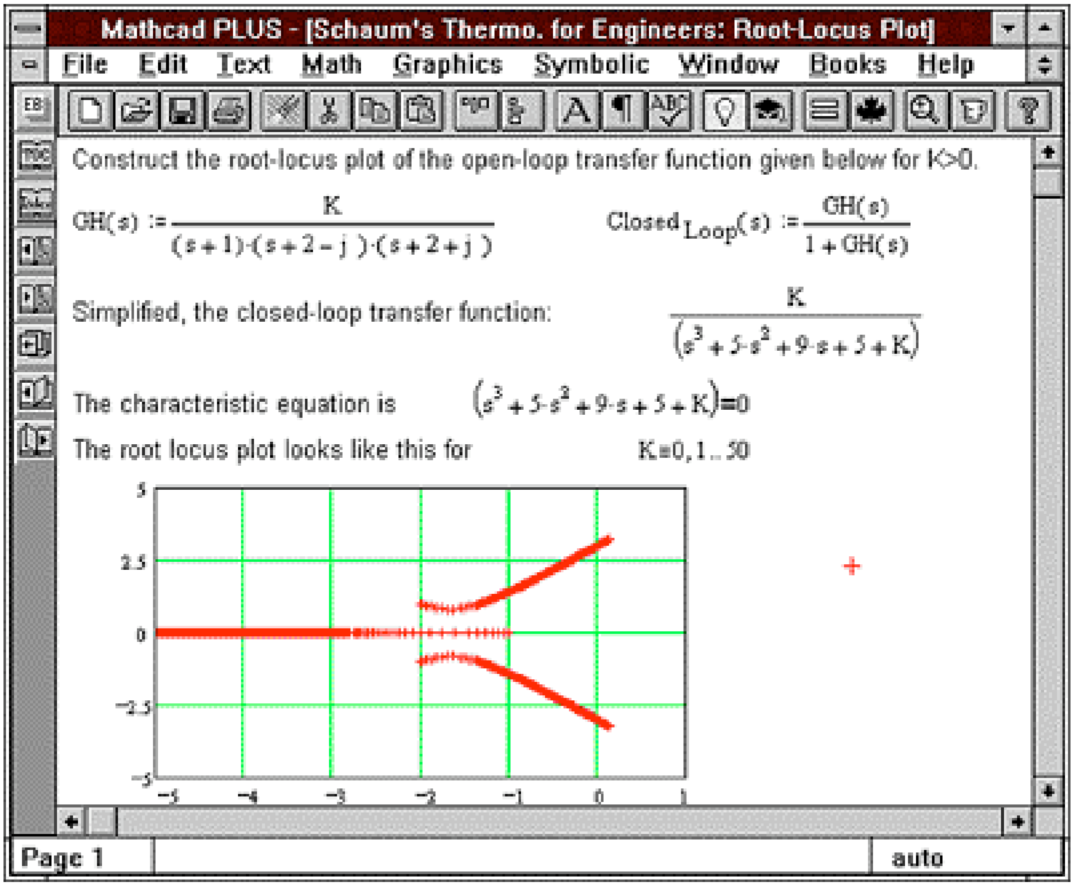
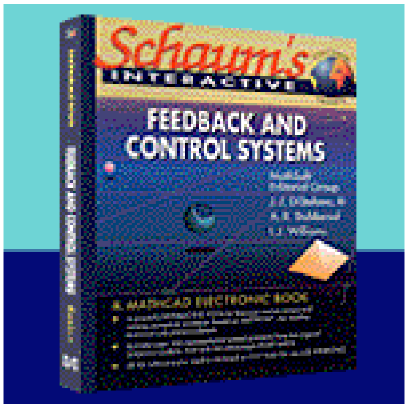


Experiment with graphing techniques for root-locus plots.

Topics include: Differential Equations, Difference Equations and Linear Systems, Stability and Routh-Hurwitz Criteria, Transfer Functions and Characteristics Equations, Block Diagram Algebra Signal Flow Graphs, Nyquist, Bode and Nichols Analysis and Design, and much more.

Feedback and Control Systems



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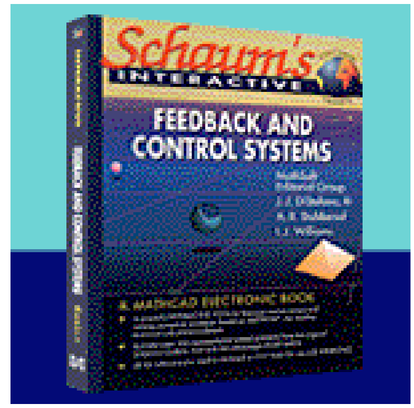

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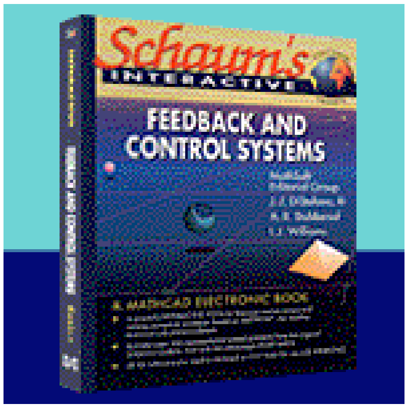

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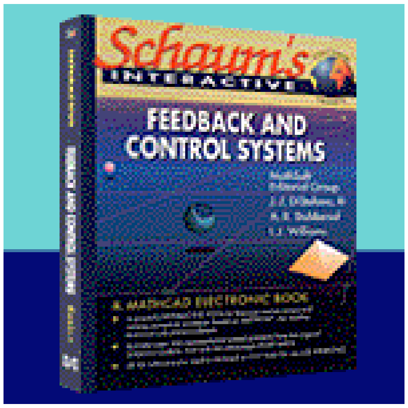

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Chapter 13 - Root-Locus Analysis

Chapter 14 - Root-Locus Design

Chapter 15 - Bode Analysis

Chapter 16 - Bode Design

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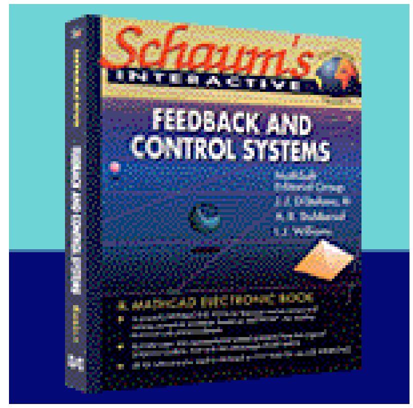

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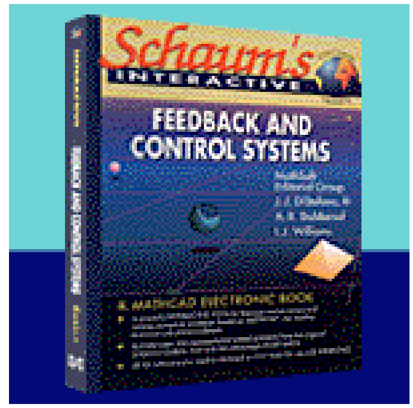

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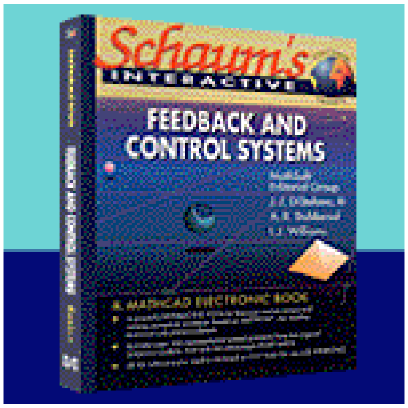

Constructing Bode Plots

Statement

Construct the Bode plot for the frequency response function given below. Also, determine the gain and phase margins for the system.

System Parameters

$$GH(\omega) := \frac{2}{j \cdot \omega \cdot \left(1 + \frac{j \cdot \omega}{2}\right) \cdot \left(1 + \frac{j \cdot \omega}{5}\right)}$$

Solution

To create the Bode plot for this function, plot the magnitude in decibels and the phase using the phase function shown in Chapter 15.

$$GH_{mag}(\omega) := 20 \cdot \log(|GH(\omega)|) \qquad phase(f) := if(arg(f) > 0, arg(f) - 2 \cdot \pi, arg(f))$$

$$\phi_{GH}(\omega) := phase(GH(\omega)) \qquad \omega := .1, .2 .. 20$$

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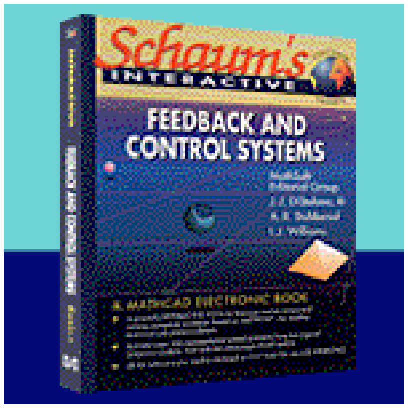

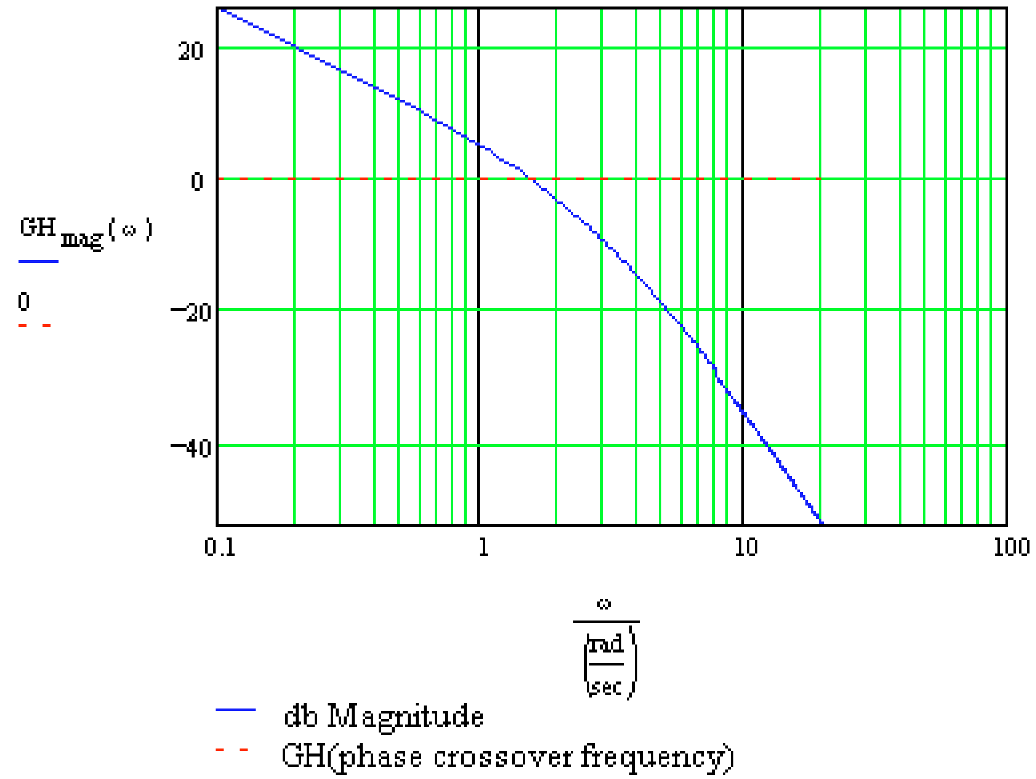

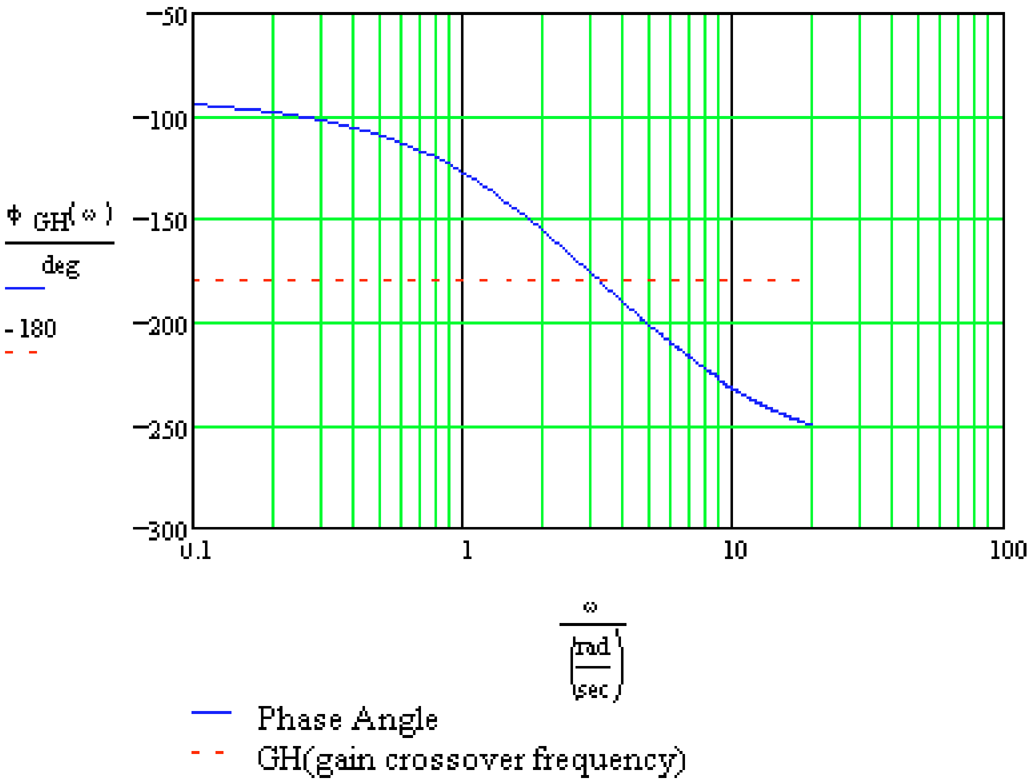

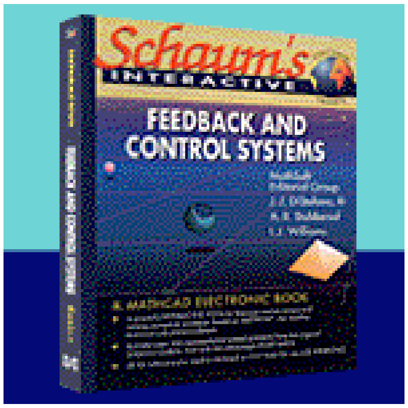

Now find the gain and phase crossover frequencies. There are two ways to do this. First, from the magnitude and phase angle plots, we can make a good guess at where $\mathbf{w_1}$ and wp are, respectively, and solve the necessary equations. Or, we could find where the two curves plotted on each the magnitude and phase angle plots intersect by setting them equal to each other and solving for **w**. Both ways are shown here. Solve for $\mathbf{w_1}$ by using the graph and for $\mathbf{w_p}$ by using the equations.

Input a guess value for $\mathbf{w_1}$ based on the magnitude plot intersection and change it until the answer to the **| GH(w) |** function is unity.

$\omega_1 := 1.52 \qquad |GH(\omega_1)| = 1$

For $\mathbf{w_p}$, set the phase equation equal to -180° (or -p) and use the **root** function.

Guess:

$\omega_g := 1 \qquad \omega_\pi := \mathrm{root}(\mathrm{phase}(GH(\omega_g)) + \pi, \omega_g)$

$\omega_\pi = 3.2 \qquad \omega_\pi = 1 \cdot \sqrt{10}$

Therefore, the gain margin is

$gain_{margin} := -20 \cdot \log(|GH(\omega_\pi)|) \qquad gain_{margin} = 10.9$

And the phase margin is

$phase_{margin} := 180 \cdot deg + \arg(GH(\omega_1)) \qquad phase_{margin} = 35.9 \cdot deg$