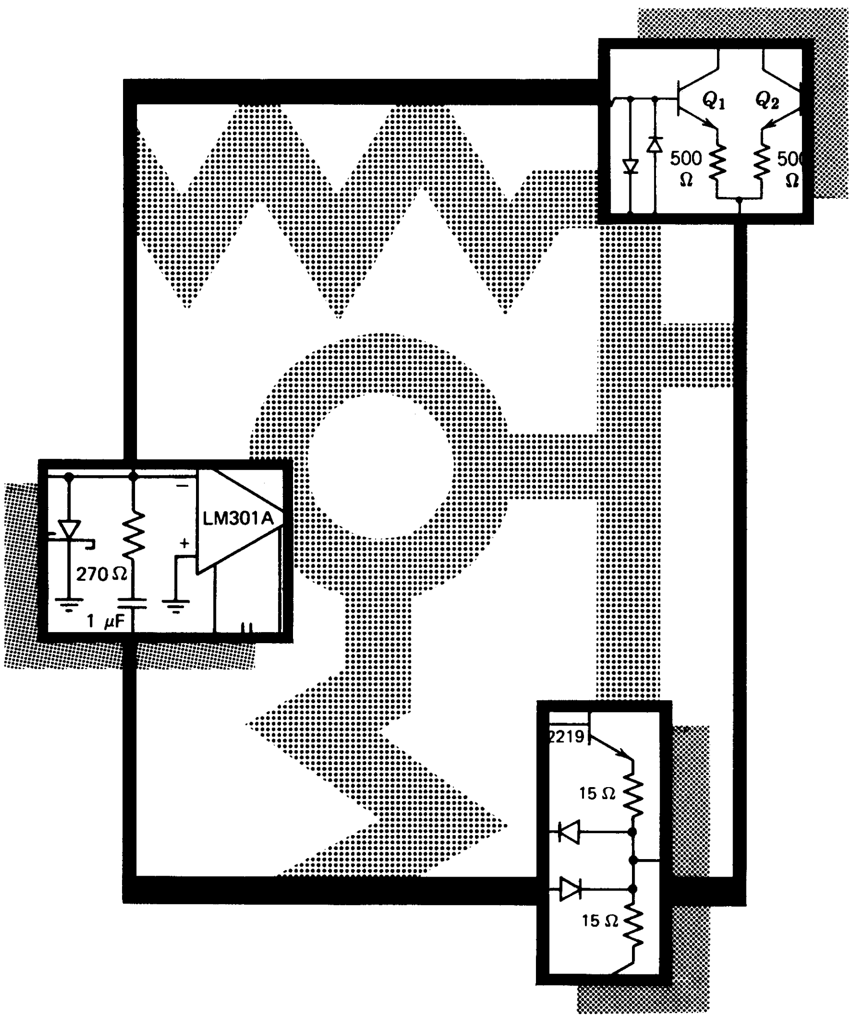
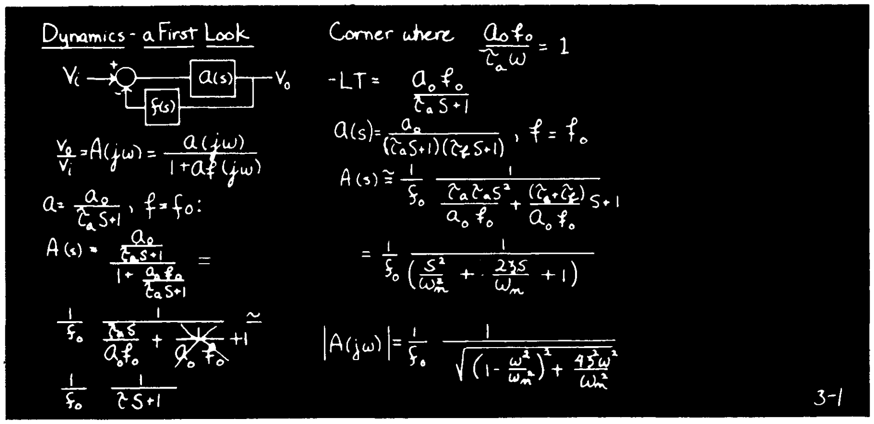
V I D E O   C O U R S E   M A N U A L

Introduction to Systems with Dynamics

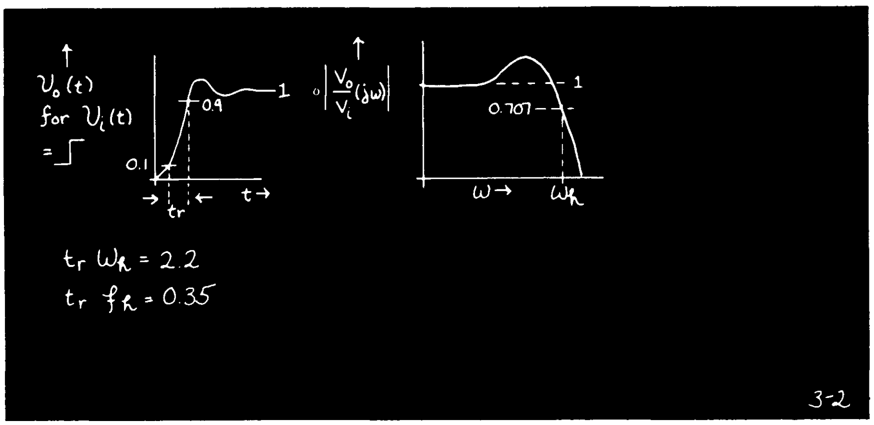
3



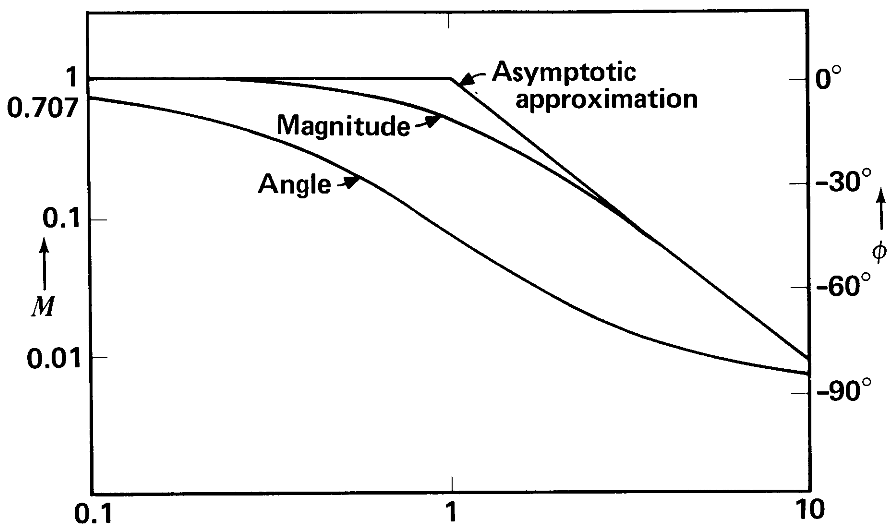
Blackboard 3.1



Blackboard 3.2

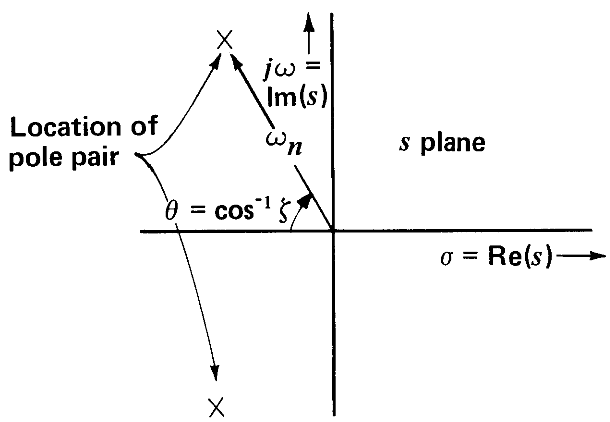


Viewgraph 3.1



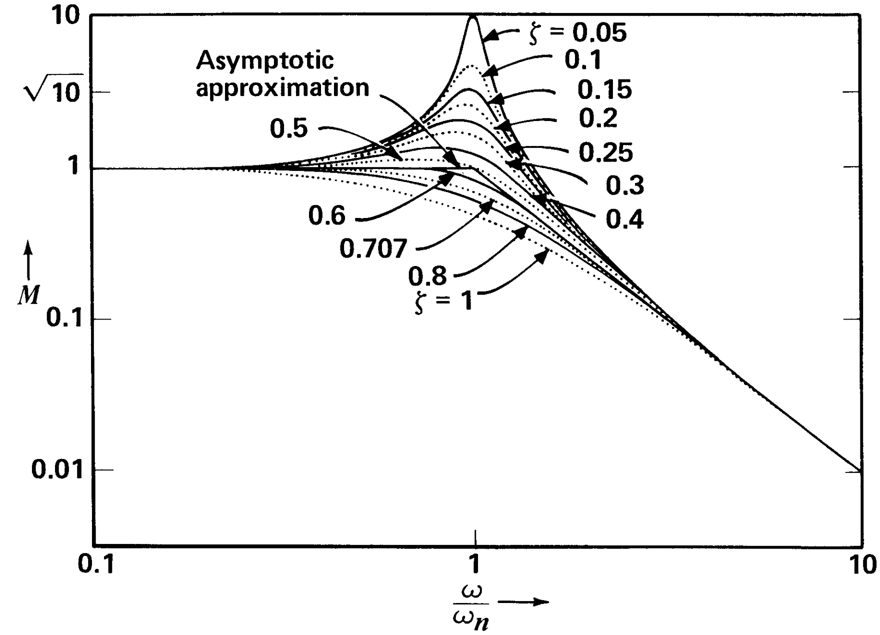
Frequency response of first-order system.

Viewgraph 3.2



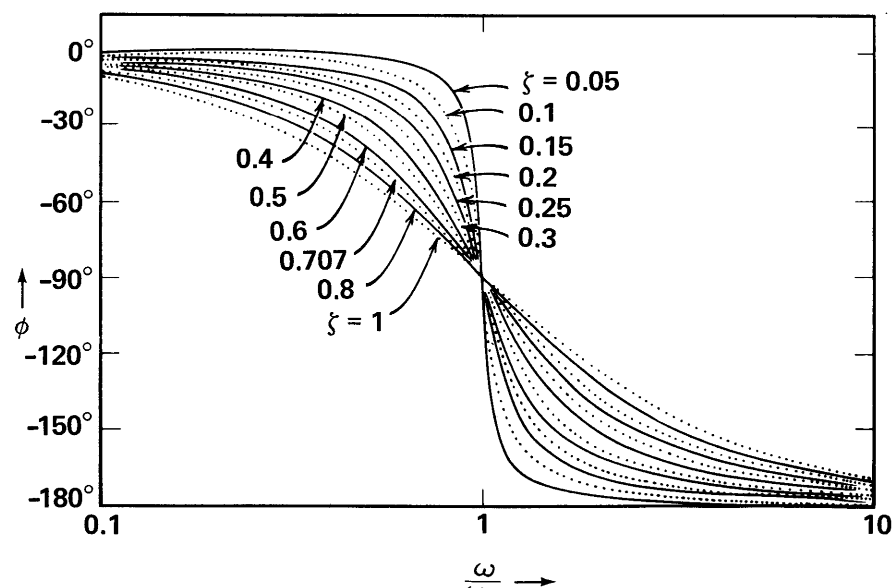
s-plane plot of complex pole pair

Viewgraph 3.3



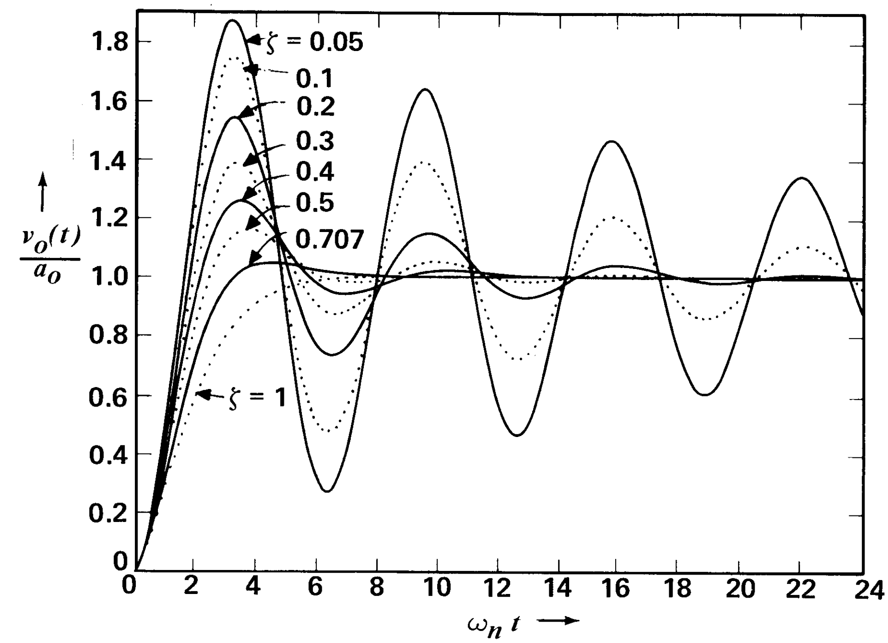
Frequency response of second-order system. (a) Magnitude

Viewgraph 3.4



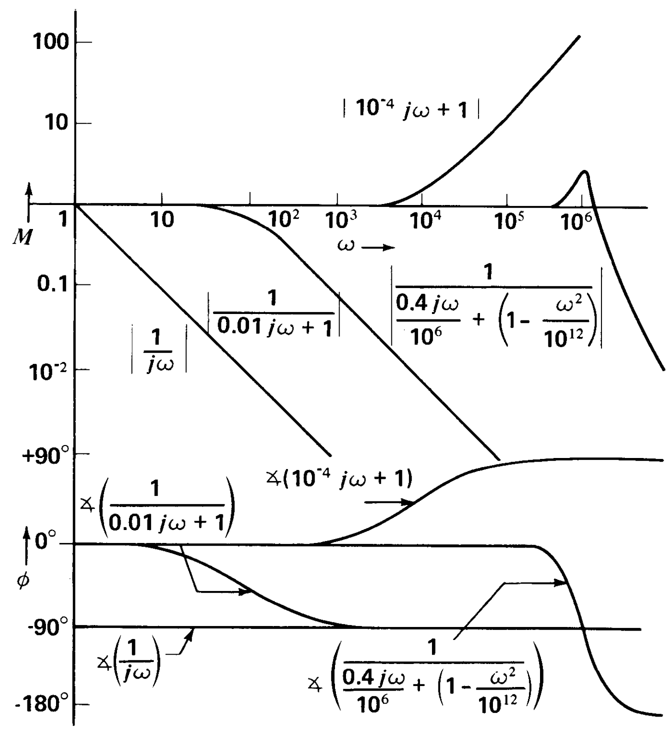
Frequency response of second-order system. (b) Angle.

Viewgraph 3.5



Step responses of second-order system.

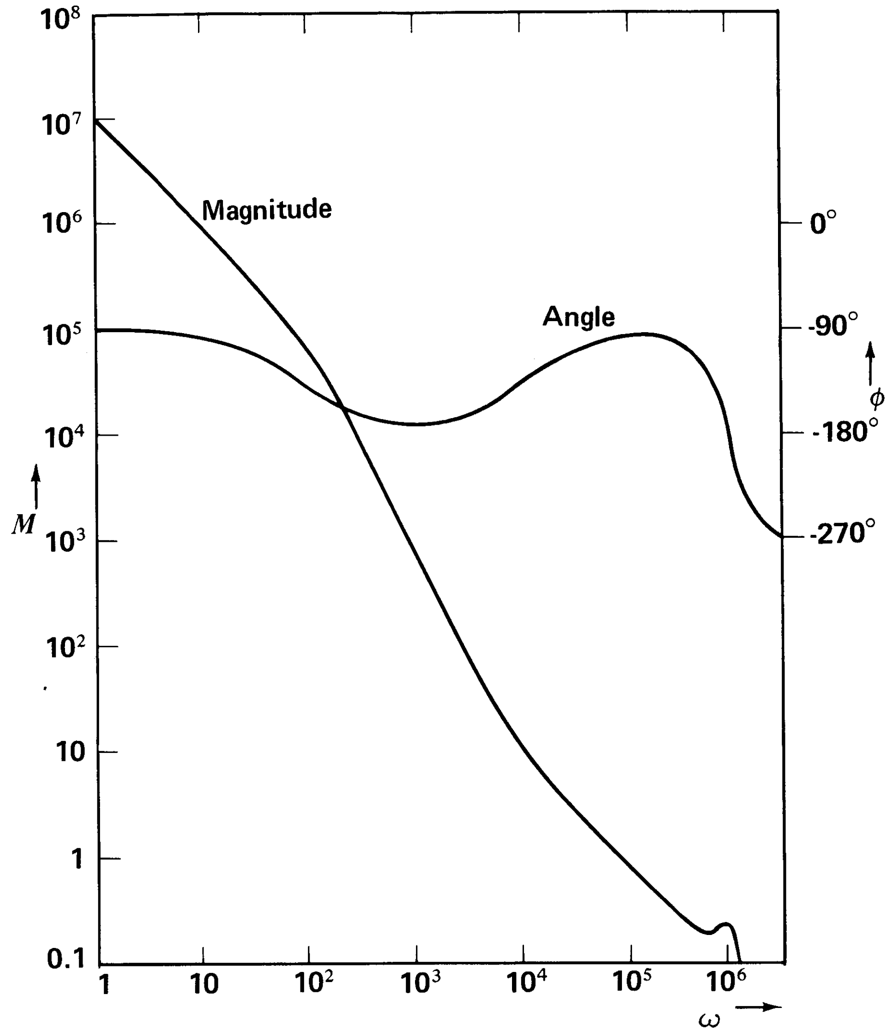
Viewgraph 3.6



(a) Individual factors

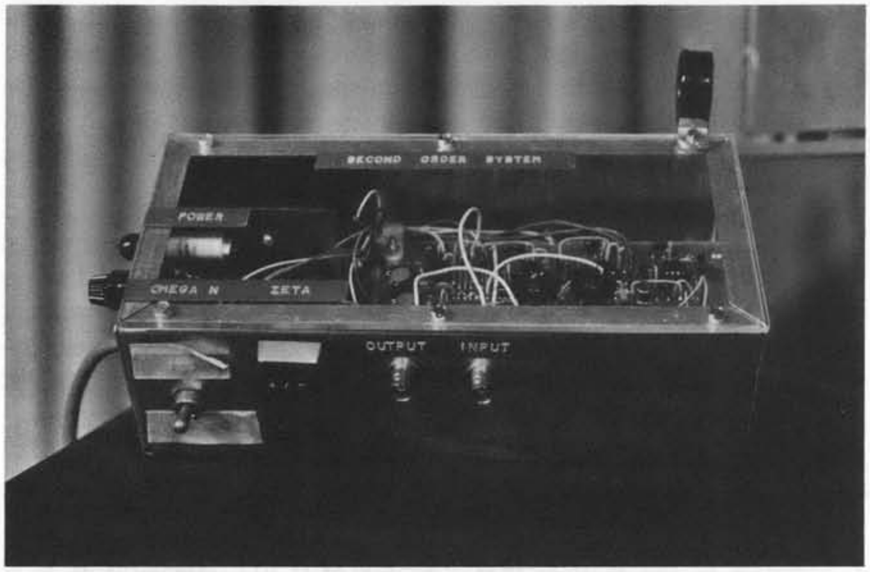
Bode plot of $\dfrac{10^7(10^{-4}s + 1)}{s(0.01s + 1)(s^2/10^{12} + 2(0.2)s/10^6 + 1)}$

Viewgraph 3.7

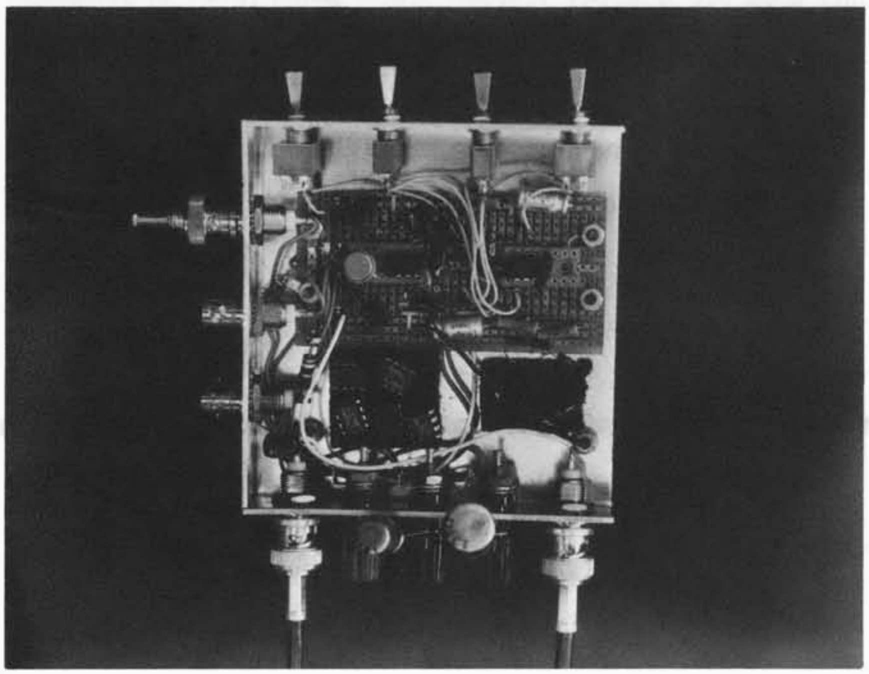


(b) Bode plot

Bode plot of $\dfrac{10^7(10^{-4}s+1)}{s(0.01s+1)(s^2/10^{12}+2(0.2)s/10^6+1)}$



Demonstration Photograph 3.1
Second-order system



Demonstration Photograph 3.2
Operational-amplifier for comparison with second-order response

Comments

This lecture serves as an introduction to the dynamics of feedback systems. Aspects of this topic form the basis for more than half the material covered here. If the dynamics of systems could be adjusted at will, it would be possible to achieve arbitrarily high desensitivities and to modify electrical or mechanical impedances in any required way.

We will never solve for the exact closed-loop transient response of a high-order system, preferring instead to estimate important properties by considering lower-order systems that accurately approximate the actual behavior. A demonstration indicating a specific example of this type of approximation is included.

Additional Discussion

I mention in the lecture that a factor of 0.707 corresponds to a -3 dB change on a decibel scale. This reflects the convention usually used for feedback systems where gains (even dimensioned ones) are converted to dB as $20 \log_{10}$ (gain).

Note that in viewgraphs 3.1, 3.3, 3.4, and 3.5, the horizontal axis is normalized so that the resultant curves can be easily scaled for any particular bandwidth system. Thus the horizontal axis in 3.1 is presented as a multiple of $\frac{1}{\tau}$, in 3.3 and 3.4 as a multiple of ω_n, and in 3.5 as a multiple of $\frac{1}{\omega_n}$.

Reading

Textbook: Sections 3.1, 3.3, 3.4, and 3.5. While we will not use the material in Section 3.2 directly, you may want to review it if you have not worked with Laplace transforms recently.

Problems

Problem 3.1 (P3.1)

Problem 3.2 (P3.2)

Problem 3.3 (P3.5)

Problem 3.4 (P3.7)

Problem 3.5 (P3.8)

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