Name _____ Section _____

ES205
Examination III
May 11, 2001

Problem	Score
1	/30
2	/20
3	/25
4	/25
Total	/100

Show all work for credit
AND
Turn in your signed help sheet

Name _____ 30 pts

ES205 Examination III **Problem 1** May 11, 2001

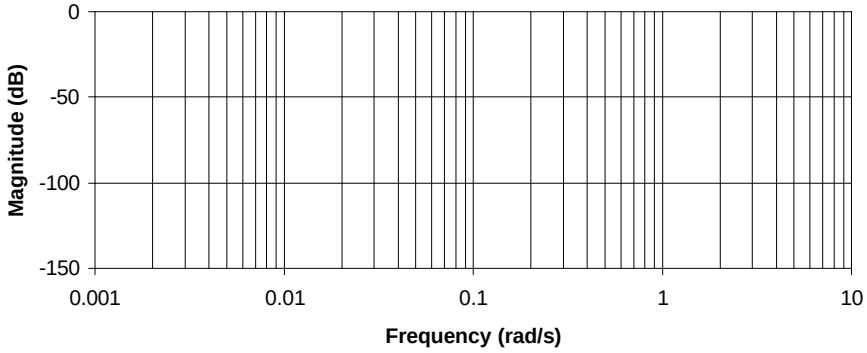
Problem 1

1.1 The amplitude of a second order system is found to decay by 50% after 3 cycles. What is the log decrement and the damping for this system? (5 pts)

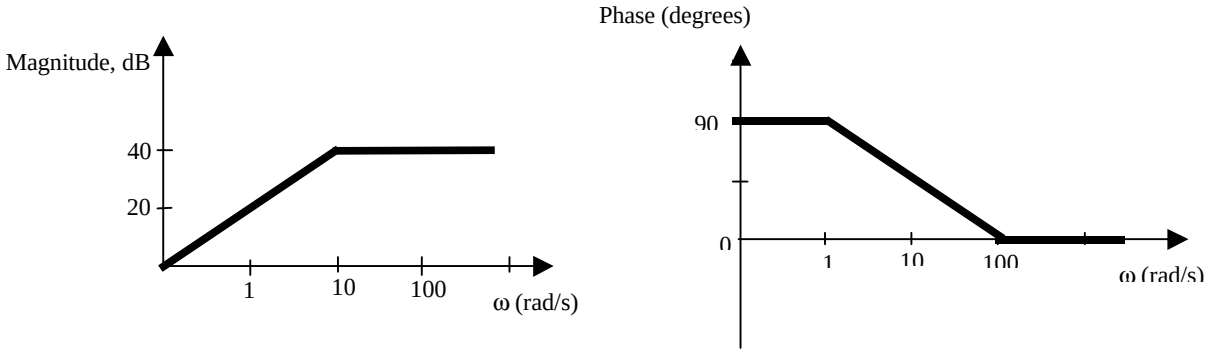
1.2 Using Matlab plot the **exact** frequency response plot for

$$TF(s) = \frac{s^2}{(100s^2 + 0.2s + 1)(s^2 + .02s + 1)}$$

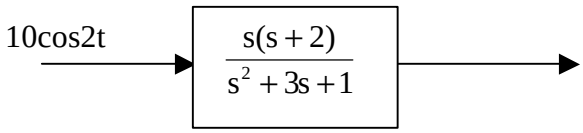
On the graph below, sketch what you see on your computer screen for the magnitude. (5 pts)



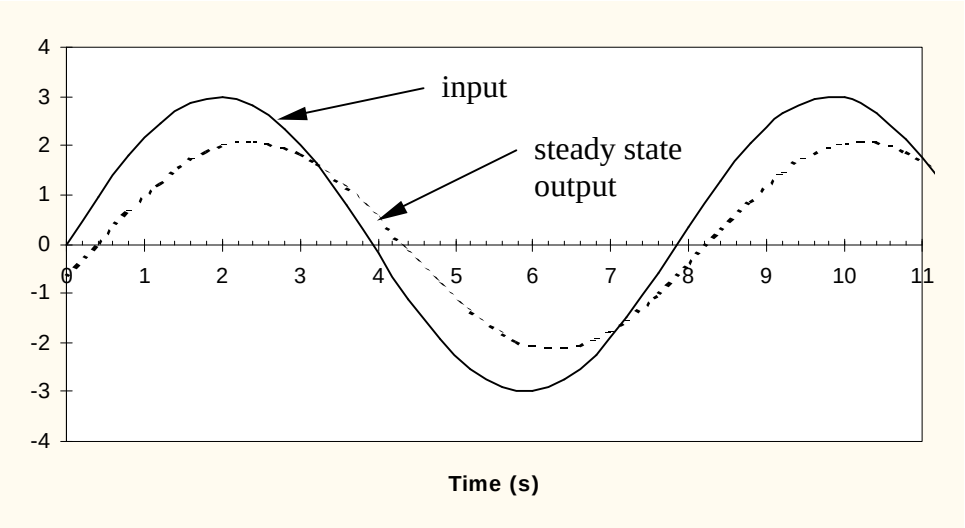
1.3 What transfer function would yield the following frequency response plot? (5 pts)



1.4 Determine the steady state response, y_{ss}, for the system shown below using the transfer function approach. (3pts)



1.5 A first order system is excited harmonically and the input and steady-state output are shown below. What is the phase angle in radians between the input and the output. Circle the best answer. (5 pts)

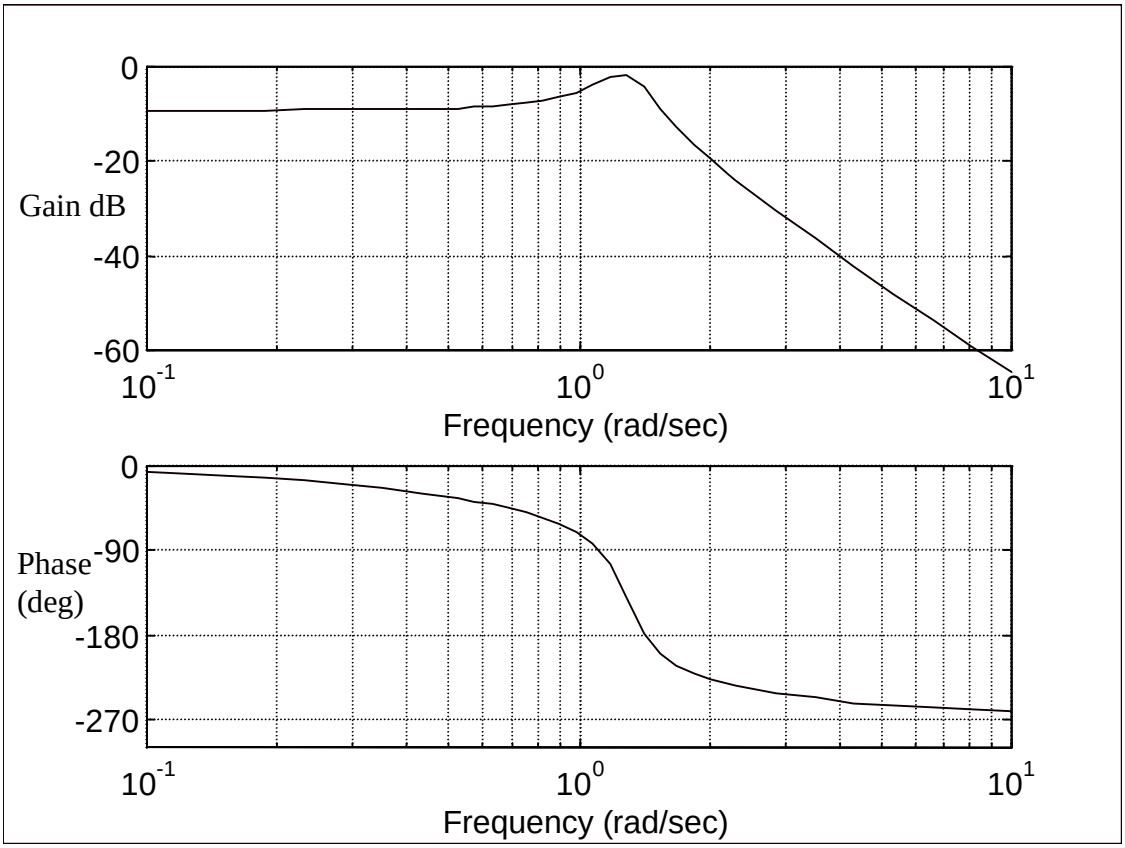


a) -0.32 rad b) -0.4 rad c) -0.051 rad d) -0.71 rad

1.6 A mechanical system which has a natural frequency ω_n and a damping ratio ζ is subjected to a forced excitation frequency ω. At steady state, the system will vibrate at (2 pts)

a) ω_n b) ω_d c) $\omega_n\sqrt{1-\zeta^2}$ d) ω e) none of the above

1.7 The frequency response plots for a system are shown below. If this system is forced with F(t) =5 + 20sin(4t) what is the steady state response? (5 pts)



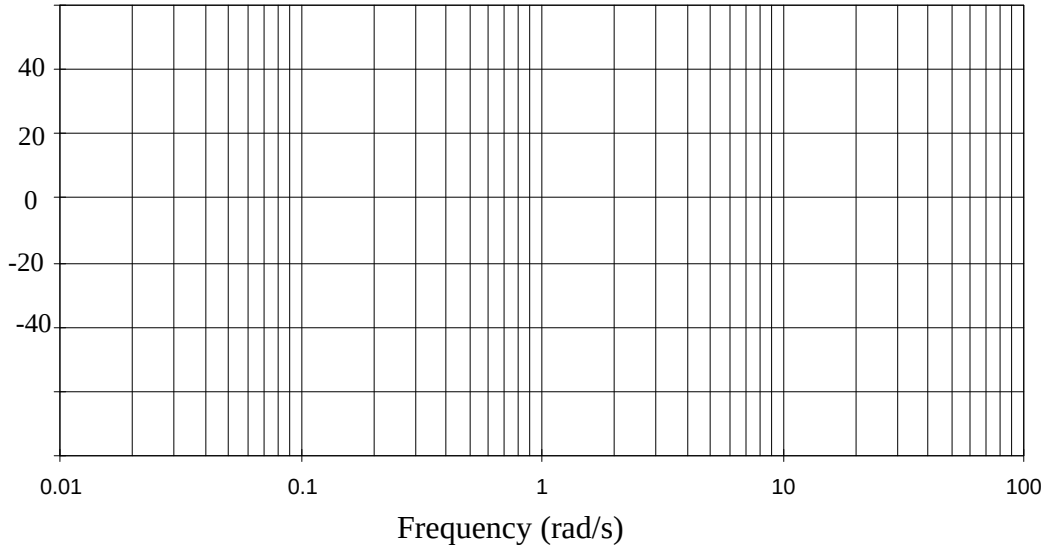
Name _____ 20 pts

ES205 Examination III **Problem 2** May 11 2001

Sketch the straight line asymptotic frequency response plots for the following transfer function. Use the semilog paper given below for this purpose. Show all work.

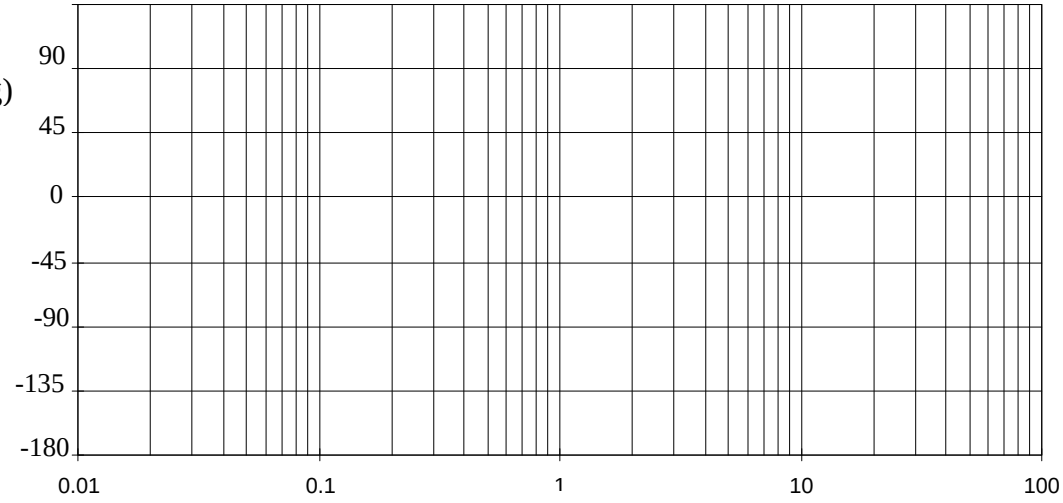
$$\frac{50s+100}{s^3+10s^2+100s}$$

Magnitude (dB)



Frequency (rad/s)

Phase (deg)

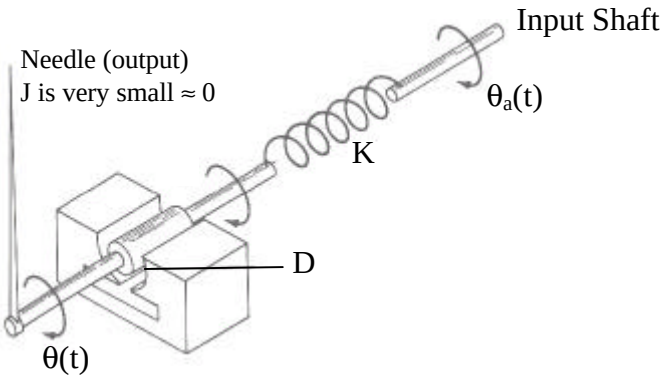


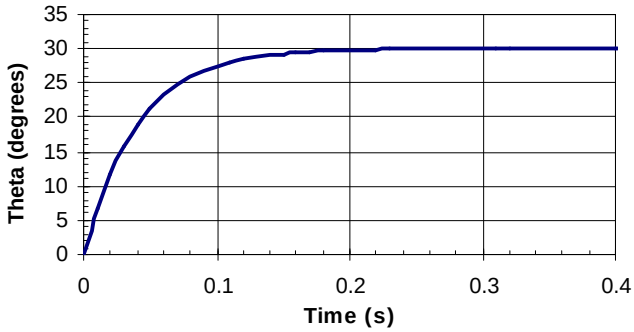
Frequency (rad/s)

Name _____ 25 pts

ES205 Examination III **Problem 3** May 11, 2001

Many instruments make use of a dial output display. To minimize jerky movements, the inputs (which may have sudden jumps and discontinuities) is not applied directly to the dial. Instead, the input mass must pass through a weak spring, which tends to filter such disturbances and thus smooth out the otherwise unreadable information. A typical device is shown below. Assume that the needle has very small mass, and also assume that the system has damping, D. A step input was applied to the system and the resulting experimental data is shown.





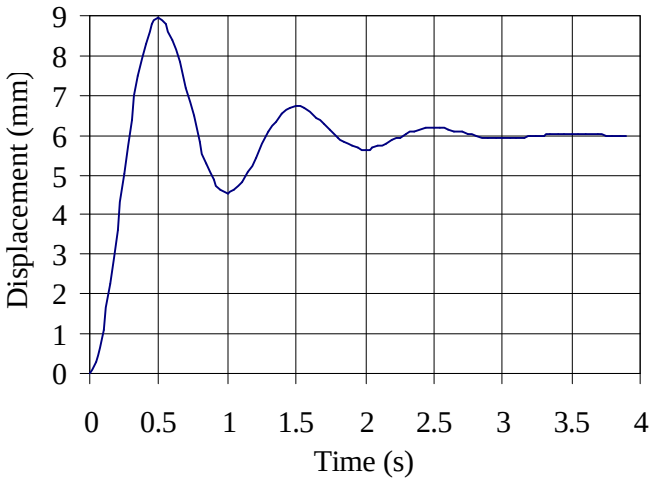
Find:

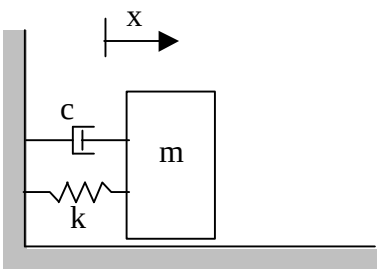
a) The time constant for this system.
b) The first order equation of motion for the system in terms of K and D.
c) The damping D assuming K = 1000 dyn-cm.
d) If the system is excited harmonically, that is, $\theta_a(t) = A \sin\omega t$, determine the range of frequencies for the steady state error to be less than 2% for the magnitude and 5 degrees for the phase.

Name _____ 25 pts

ES205 Examination III **Problem 4** May 11, 2001

A unit step input is applied to the mass shown below resulting in the accompanying time history.





EOM for t>0

$$m\ddot{x} + c\dot{x} + kx = 1$$

Determine:

a) the static gain
b) the damping ratio of the system
c) the natural frequency of the system
d) Determine m, k and c.
e) What is the steady state response if this system is forced with 100sin50t N? (Note: you do not need the answer to d) to solve this part of the problem).