Name _____ Section _____

ES205
Examination III
May 12, 2000

Problem	Score
1	/35
2	/30
3	/35
Total	/100

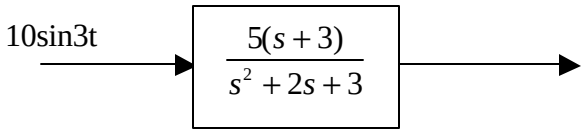
Show all work for credit
AND
Turn in your signed help sheet

Name _____ 35 pts

ES205 Examination III **Problem 1** May 14, 1999

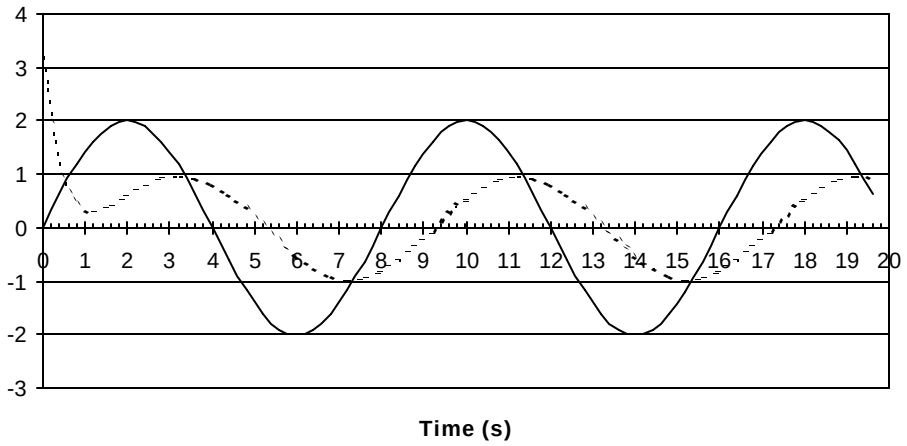
Problem 1

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



1.2 – 1.4

A first order system is excited harmonically, f(t) = 2 sin(0.785t) and the input and total response (transient and steady state) are shown below. Answer the following questions:



1.2 What is the phase angle in radians between the input and the output? (3pts)

1.3 What is the time constant for the system? (3 pts)

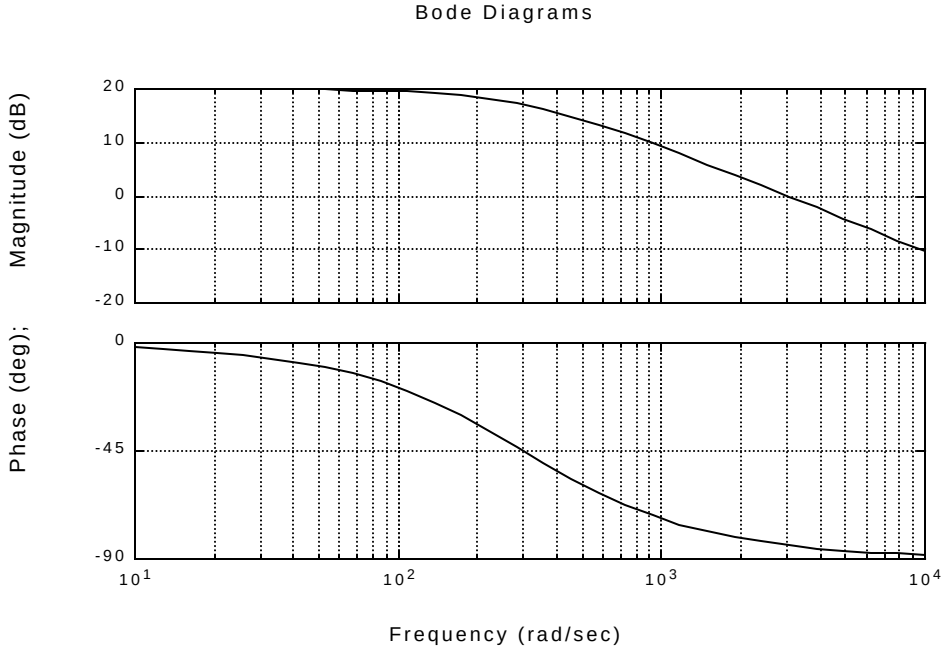
1.4 What is the static gain for the system? (3 pts)

1.5 A second order system is forced harmonically is shown below:

$$\frac{\ddot{x}}{\omega_n^2} + \frac{2\zeta}{\omega_n}\dot{x} + x = 10\sin\omega t$$

For what range of frequency ratio, that is $r = \omega/\omega_n$, will the magnitude of the steady state output be larger than 10 assuming the damping is very small? Express your answer as a range of values, ? < r < ?. (3 pts)

1.6 What transfer function would yield the following frequency response plot? (3pts)



1.7 If the system shown in Problem 1.6 is forced with f(t) = 12cos(900t) what would the steady state response be? (3 pts)

1.8-1.10 A second order system is subjected to a step input with zero initial conditions.

1.8 In what ways can you reduce the percent overshoot of the system? Circle all the correct answers. (2pts)

a) Increase the damping ratio
b) Decrease the damping ratio
c) Increase the natural frequency
d) Decrease the natural frequency
e) Increase the damped natural frequency
f) Decrease the damped natural frequency

1.9 In what ways can you decrease the time to the first peak? Circle all the correct answers. (3 pts)

a) Increase the damping ratio
b) Decrease the damping ratio
c) Increase the natural frequency
d) Decrease the natural frequency
e) Increase the damped natural frequency
f) Decrease the damped natural frequency

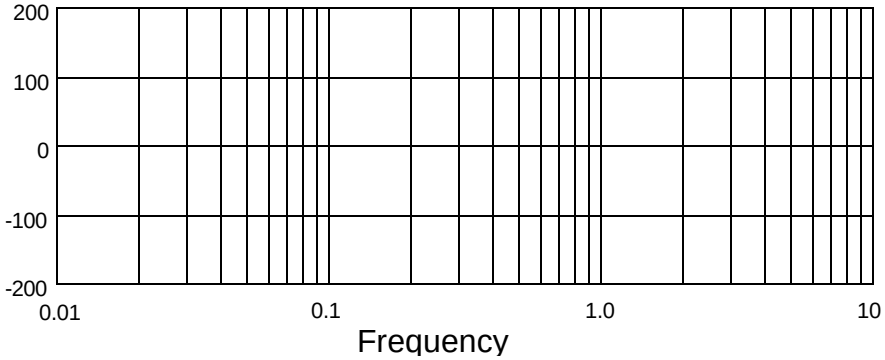
1.10 In what ways can you decrease the settling time? Circle all the correct answers. (3 pts)

a) Increase the damping ratio
b) Decrease the damping ratio
c) Increase the natural frequency
d) Decrease the natural frequency
e) Increase the damped natural frequency
f) Decrease the damped natural frequency

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

$$TF(s) = \frac{100s^2 + 0.1s + 1}{\left(s^2 + 0.01s + 1\right)\left(10s^2 + .1s + 2\right)}$$

On the graph below, sketch what you see on your computer screen for the phase. (3 pts)



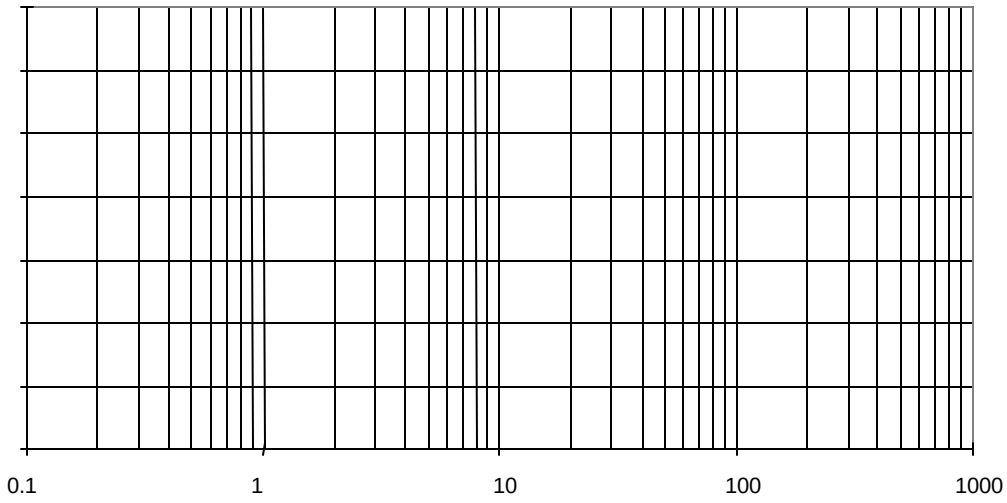
1.12 Start Matlab and Simulink. Open "Simulink Extras". The first submenu item is called "additional discrete". What is the sixth item called? (3 pts)

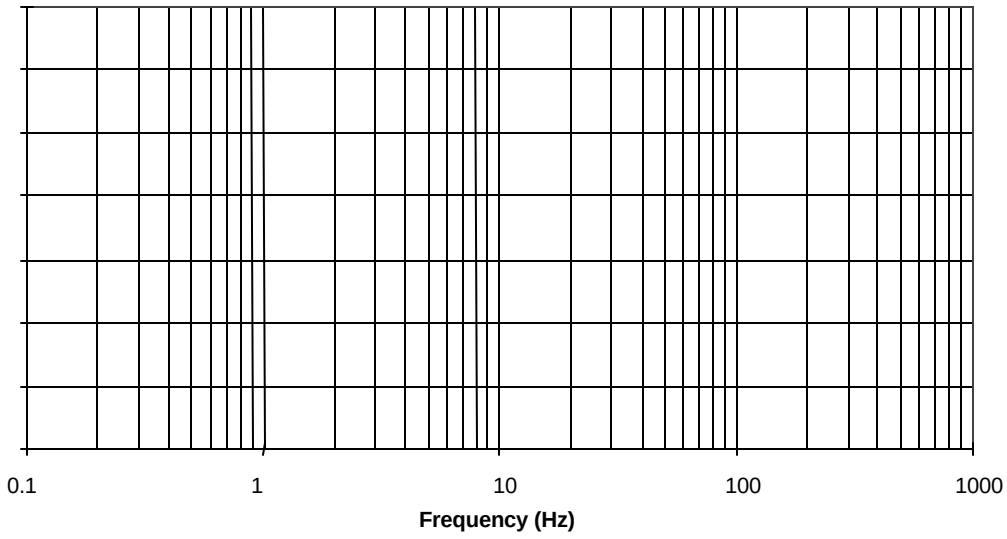
1.13 Name _____ 30 pts

ES205 Examination III **Problem 2** May 12, 2000

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 for full credit.

$$\frac{9000(s+1)}{s(s^2+10s+900)}$$





Name _____ 35 pts

ES205 Examination III **Problem 3** May 12, 2000

A loaded railroad car weighing 35,000 lb is rolling at a constant velocity when it couples with a spring and dashpot bumper system. If the recorded displacement-time curve of the loaded railroad car after coupling is as shown, determine:

a) the damping ratio, ζ (8 pts)
b) the spring constant, k of the bumper system (15 pts)
c) the damping ratio, ζ, of the system when the railroad car is empty. The unloaded car weighs 8000 lb. (10 pts)
d) the velocity of the car before it impacted the spring/dashpot system (2 pts – I'll give you one point if you just explain how you would do this.)