Name _____ Section _____

ES205
Examination III
May 16, 1997

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

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

Name _____ /25

ES205 Examination III **Problem 1** May 16, 1997

For problems 1.1-1.10 show all work for credit where appropriate (2.5 pts/part)

1.1 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

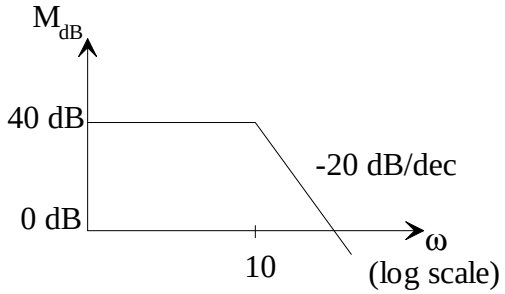
a) ω_n b) ω_d c) $\omega_n\sqrt{1-\zeta^2}$ d) ω e) none of the above

1.2 A straight-line asymptotic magnitude plot, a.k.a. Bode magnitude diagram, for a system is shown below. Circle the transfer function that would yield this diagram.

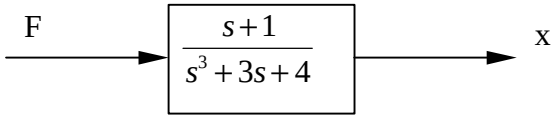
a) $TF = \dfrac{40}{\frac{s}{10}+1}$ b) $TF = \dfrac{10}{10s+1}$

c) $TF = \dfrac{1000}{s+10}$ d) $TF = \dfrac{10}{\frac{s}{40}+1}$

e) $TF = \dfrac{1000}{10s+1}$ f) none of the above



1.3 What differential equation is represented by the following transfer function?



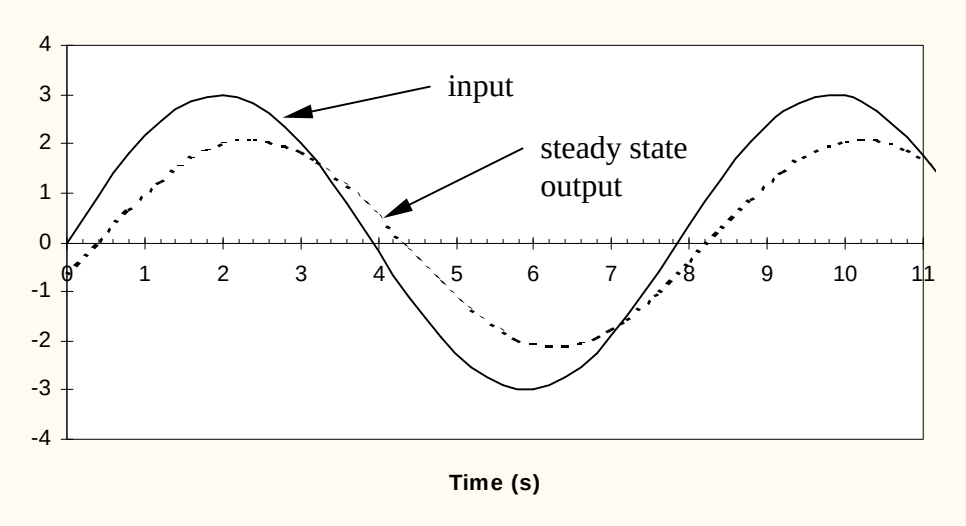
1.4 A step input of magnitude 2 is applied to a second order system described by the EOM $3\ddot{x}+6\dot{x}+12x=36f(t)$. What is the amplitude of the output at steady state?

a) 2.0 b) 6.0 c) 24.0 d) 72.0 e) none of the above

1.5 A harmonic input f(t) = 2 sin(4t) is applied to a first order system described by the EOM $6\dot{x}+3x=12f(t)$. What is the amplitude of the output at steady state?

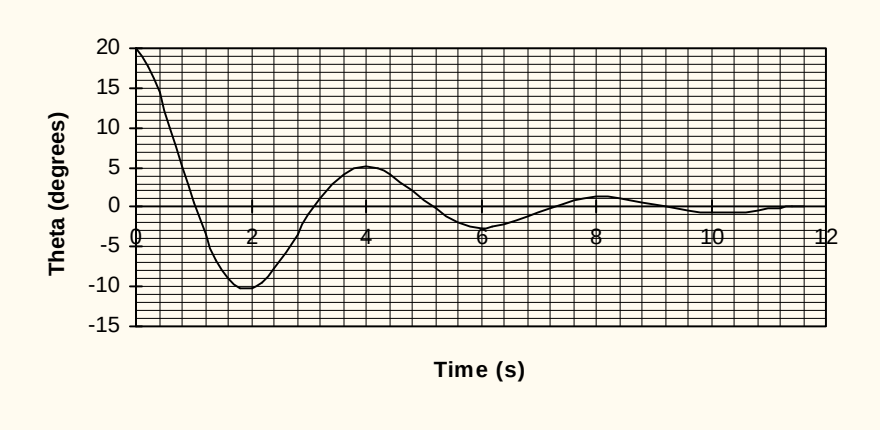
a) 1.0 b) 2.0 c) 3.0 d) 8.0 e) 24.0

1.6 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.



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

Use the free response of a second order system shown below for problems 1.7-1.9

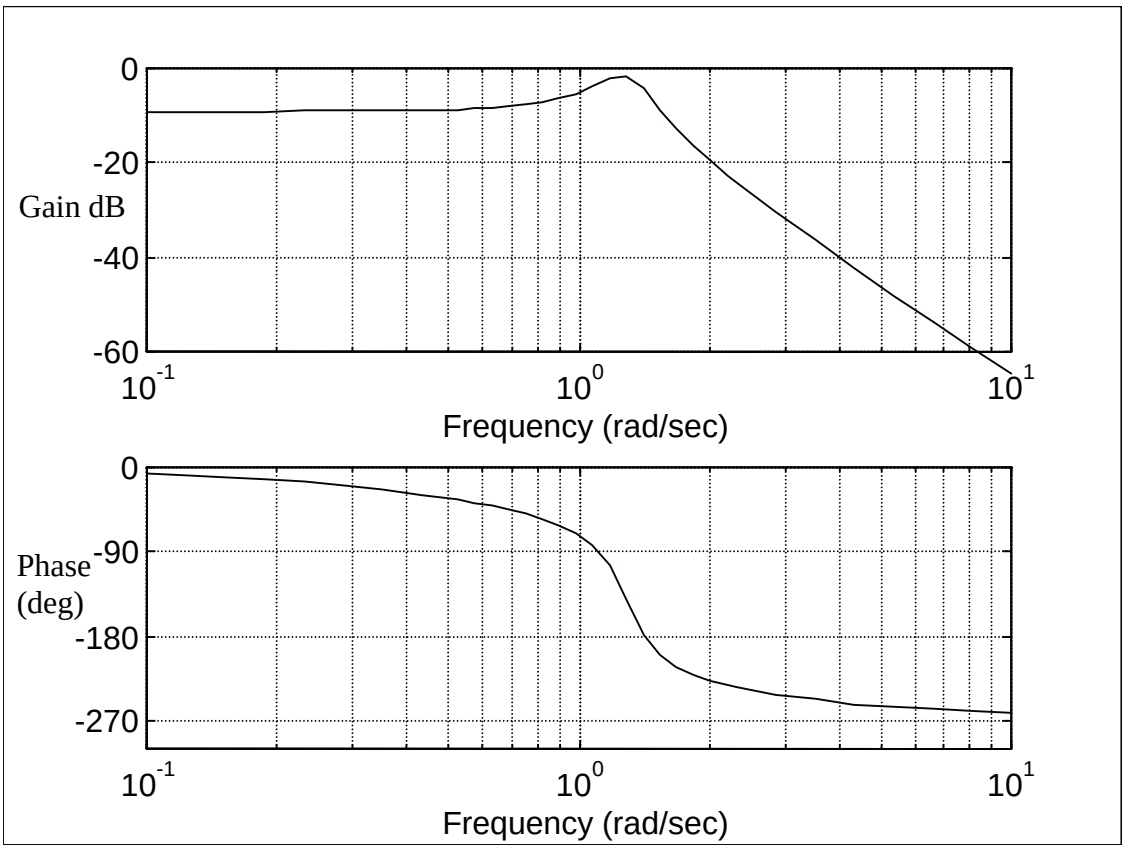


1.7 What is the log decrement?

1.8 What is the damping ratio?

1.9 What is the natural frequency?

1.10 The frequency response plots for a system are shown below. If this system is forced with F(t) = 10sin(2t) what is the steady state response?



a) 0.1 sin(2t-225°)
b) 0.3 sin(2t-240°)
c) 1.0 sin(2t-225°)
d) 10 sin(2t)
e) 10 sin(2t-225°)
f) -200 sin(2t-225°)

Name _____ /25

ES205 Examination III **Problem 2** May 16, 1997

An electro-mechanical system was modeled and the following differential equations were derived using conservation principles. The system has two inputs r_1 and r_2 and one output c.

$$k_0\dot{x} + x = k_1(r_1 - z)$$
$$c = r_2 + x$$
$$k_2\dot{z} = k_3 c$$

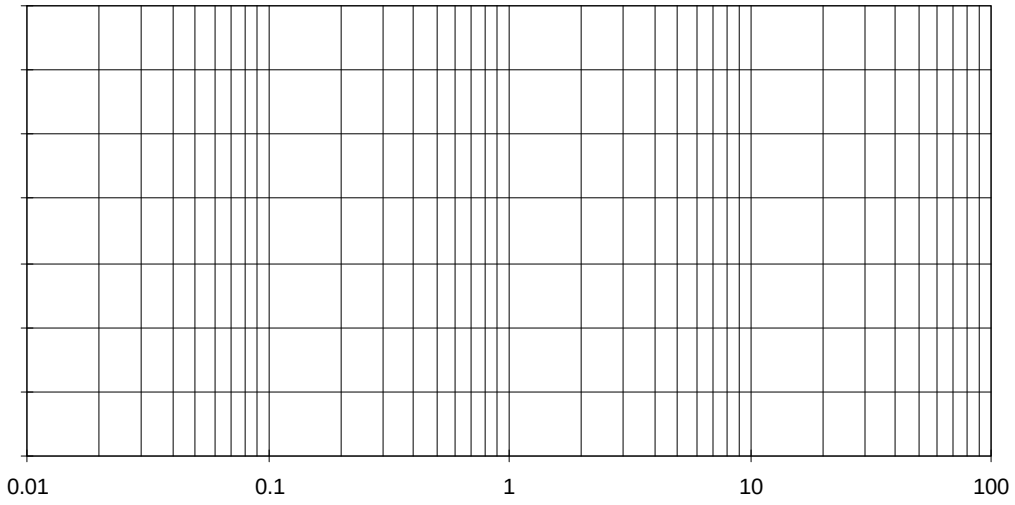
Draw the block diagram for this electro-mechanical system. Note: x and z are intermediate variables.

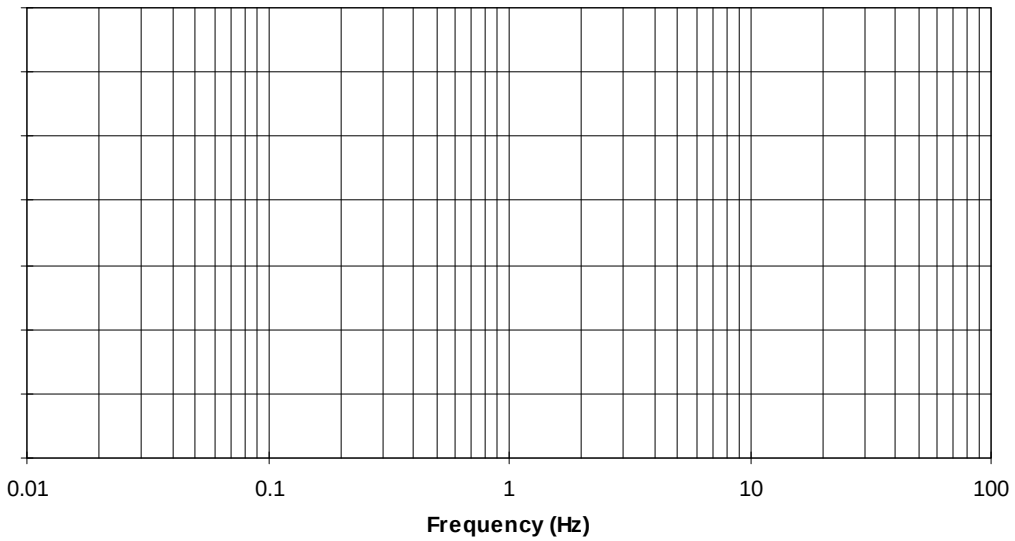
Name _____ /25

ES205 Examination III **Problem 3** May 16, 1997

Sketch the straight line asymptotic frequency response plots for the following transfer function. Use the semi-log graph paper provided for this purpose. Be sure to show all your work for credit.

$$TF(s) = \frac{-5000(s+0.1)^2}{s^2(s+5)}$$





Name _____ /25

ES205 Examination III **Problem 4** May 16, 1997

You have been hired to design a spring and a damper for an amusement park gate. The gate has already been purchased and consists of a concentrated mass M at the end of the bar and a distributed mass m as shown below. The mass moment of inertia of the gate about its hinge is found to be I_0=80 kg-m^2. Determine the values of the torsional spring constant, k_t, and the torsional viscous damper, C_t, required to meet the following performance specifications when it is released from rest from an initial position of $\theta = 75$ degrees. The equation of motion is: $I_0\ddot{q} + C_t\dot{q} + k_t q = 0$

Performance Specifications:

- The percent overshoot should be less than 15%
- The time to reach the first peak should be less than 0.5 seconds
- The time to reach 2% of the final resting position should be less than 2 seconds