Name _____ Section _____

ES205
Examination I
March 25, 2002

Problem	Score
1	/30
2	/30
3	/40
Total	/100

Show all work for credit
AND
Turn in your signed help sheet
AND
Stay in your seat until the class ends
(Translation: we are not going to let you leave early,
so you might as well check your answers!)

Name _____ 30 pts

ES205 Examination I **Problem 1** March 25, 2002

You must show all work for full credit on these problems.

1.1) (5 pts) Given the transfer function for a bridged-T network:

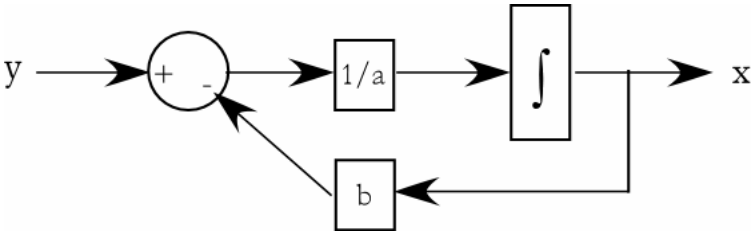
$$\frac{V_0(s)}{V_{in}(s)} = \frac{1 + 2R_1Cs + R_1R_2C^2s^2}{1 + (2R_1 + R_2)Cs + R_1R_2C^2s^2}$$ find the corresponding differential equation of motion for this system (5 pts)

1.2) (5 pts) Given the simulation diagram below, find:

a) the system's time constant

b) the system's static gain constant

c) the differential equation relating y(t) to x(t)



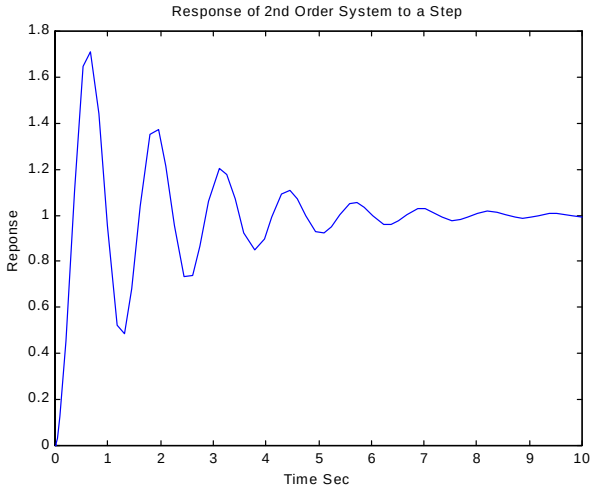
1.3) (5 pts) Given the 2nd order differential equation of motion: $\ddot{y} + 4\dot{y} + 4y = u$, determine an appropriate state-space description.

1.4) (4pts) For the system described by the equation $5\ddot{x} + 16\dot{x} + 80x = 800f(t)$ with f(t) as the input, find:

a) the undamped natural frequency
b) the damping ratio
c) the damped natural frequency
d) the static gain constant

1.5) (3 pts) The response of a second order system to a step, f(t) = 10u(t), is shown below. The system shown may be described as follows:

a) undamped b) underdamped c) critically damped d) overdamped e) none of these



1.6) (3 pts) If the system shown in problem 1.5 is excited with a step, f(t) = 6u(t), what is the steady state response of the system?

1.7) (5 pts) Given the transfer function $\frac{Y(s)}{R(s)} = \frac{20}{s^2 + 8s + 15}$ and the corresponding differential equation of motion: $\ddot{y} + 8\dot{y} + 15y = 20r$, draw the corresponding simulation diagram using only gains, integrators, and sum blocks.

Name _____ 30 pts

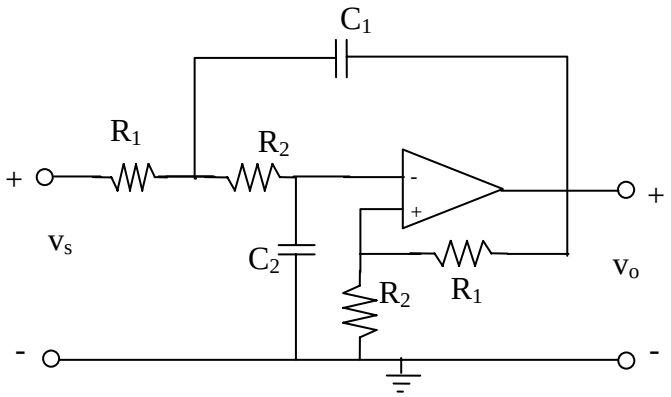
ES205 Examination I **Problem 2** March 25, 2002

A low-pass Sallen and Key circuit is shown below. Determine

a) the transfer function between the input v_s and the output v_o

b) the natural frequency of this circuit (2 pts)

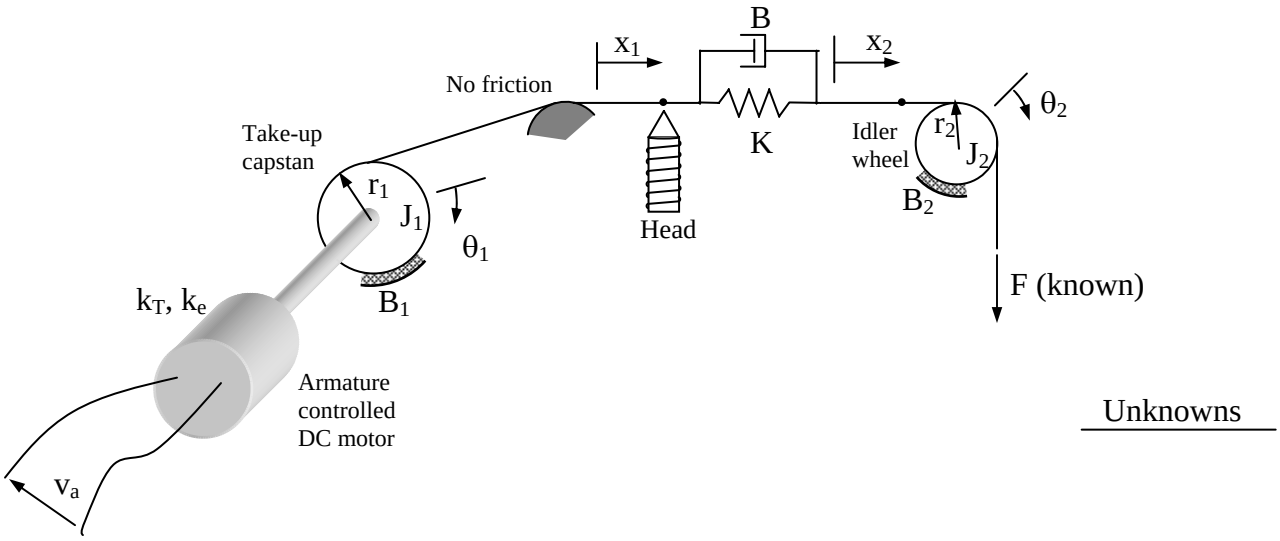
Note: Set up the equations first (clearly numbered equations and a list of unknowns) and save the solution until all the other problems on the test have been solved (the actual transfer function is only worth a few points). Be sure to clearly label all your variables on the circuit diagram.



Name _____ 40 pts

ES205 Examination I **Problem 3** March 25, 2002

For the tape drive shown below determine the necessary equations to find the differential equation of motion (EOM) that relates the known input voltage, v_a, to the unknown output displacement, x_1. Assume the output shaft of the motor is rigid. Hint: The tension in the tape will change from one side of the idler wheel to the other. **Do not find the EOM but number the equations that you would use and generate a list of the unknown variables**.



Unknowns