Duke University
Edmund T. Pratt, Jr. School of Engineering

ECE 141 Spring 2006

Test I

Michael R. Gustafson II

Name (please print)_____

In keeping with the Community Standard, I have neither provided nor received any assistance on this test. I understand if it is later determined that I gave or received assistance, I will be brought before the Undergraduate Judicial Board and, if found responsible for academic dishonesty or academic contempt, fail the class. I also understand that I am not allowed to speak to anyone except the instructor about any aspect of this test until the instructor announces it is allowed. I understand if it is later determined that I did speak to another person about the test before the instructor said it was allowed, I will be brought before the Undergraduate Judicial Board and, if found responsible for academic dishonesty or academic contempt, fail the class.

Signature:_____

Problem I: [20 pts.] Solving Differential Equations

Using Laplace Transforms and clearly showing your work, determine an equation for $x(t)$ given the following:

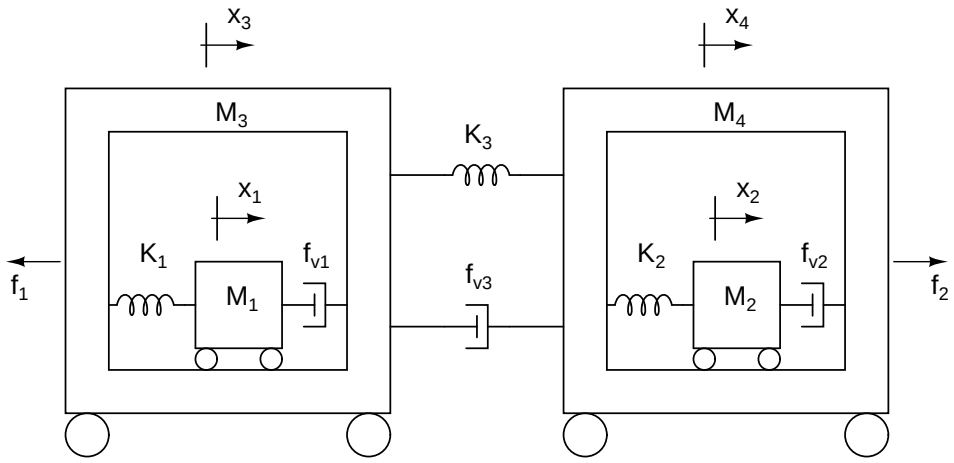
$$\frac{d^2x(t)}{dt^2} + 6\frac{dx(t)}{dt} + 34x(t) = e^{-2t}\cos(t)$$
$$\dot{x}(0) = 1$$
$$x(0) = 0$$

Note: not *all* numbers are necessarily nice here.

Name (please print):
Community Standard (print ACPUB ID):

Problem II: [15 pts.] Translational Transfer Functions

Given the system below,



set up, but do not solve, the four required equations of motion in the frequency domain. Your answer should be presented in matrix form.

Name (please print):
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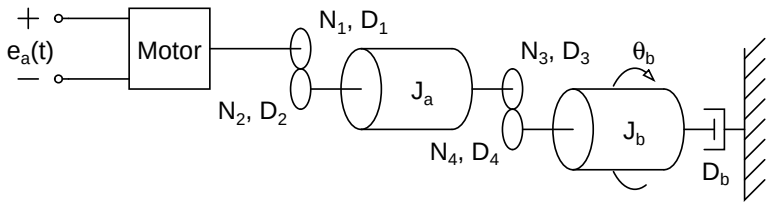
Problem III: [25 pts.] Rotational Systems and Motors

Given the system below:



and the values:

$J_a = 200$kg-m^2	$D_1 = 2$N-m s/rad
$J_b = 3200$kg-m^2	$D_2 = 200$N-m s/rad
$N_1 = 2$	$D_3 = 200$N-m s/rad
$N_2 = 20$	$D_4 = 1600$N-m s/rad
$N_3 = 10$	$D_b = 6400$N-m s/rad
$N_4 = 40$	

and the knowledge that the relationship of the motor torque to motor speed is:

$$T_m = 500\text{N-m} - (25\text{N-m s/rad})\,\omega_m$$

when e_a=10V.

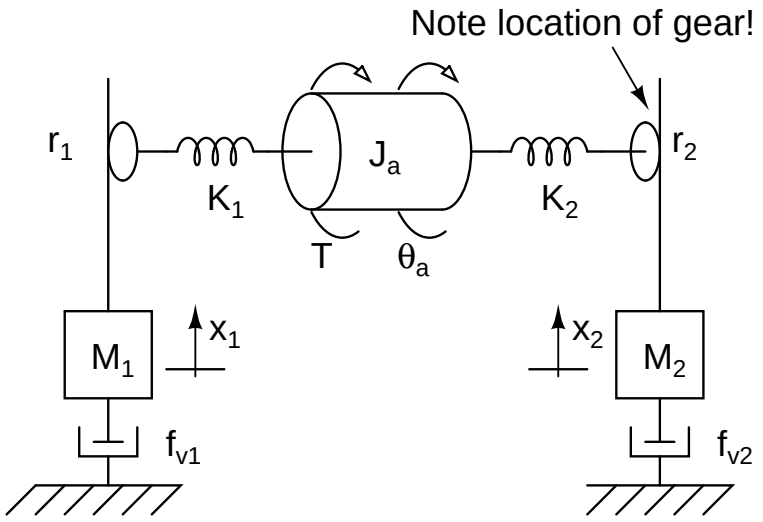
(a) Determine the transfer function $G(s) = \Theta_b(s)/E_a(s)$

(b) Determine $\theta_b(t)$ if $e_a(t) = (1 - e^{-2t})u(t)$ **Note:** not *all* numbers are necessarily nice here, either.

Name (please print):
Community Standard (print ACPUB ID):

Problem IV: [20 pts.] Hybrid Systems

Given the model for a dumbwaiter system below:



(a) Set up, but do not solve, the required equations of motion in the frequency domain. Your answer should be presented in matrix form.

(b) Determine the value of the transfer function $R(s) = X_1(s)/\Theta_a(s)$.

Name (please print):
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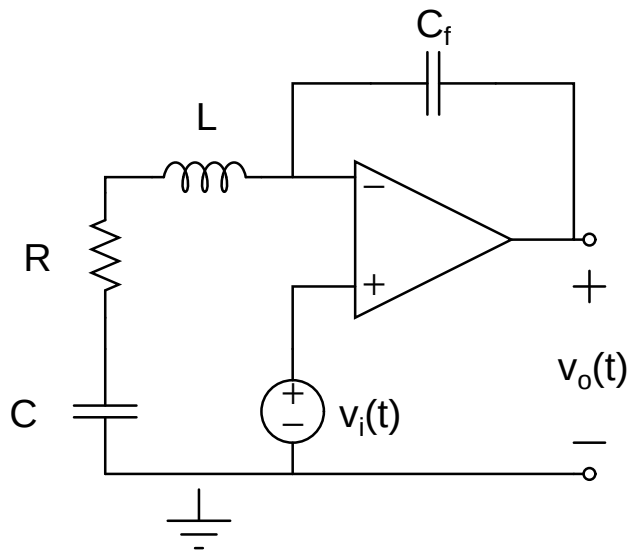
Problem V: [20 pts.] Electrical Systems

Given the circuit below:



(1) Determine the transfer function $G(s) = V_o(s)/V_i(s)$.

(2) Determine the step response $v_o(t)$ (i.e. the response when $v_i(t) = u(t)$) if $C = C_f = 0.625\text{F}$, $R = 1\Omega$, and $L = 0.1\text{H}$.