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

ECE 141 Spring 2007

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:

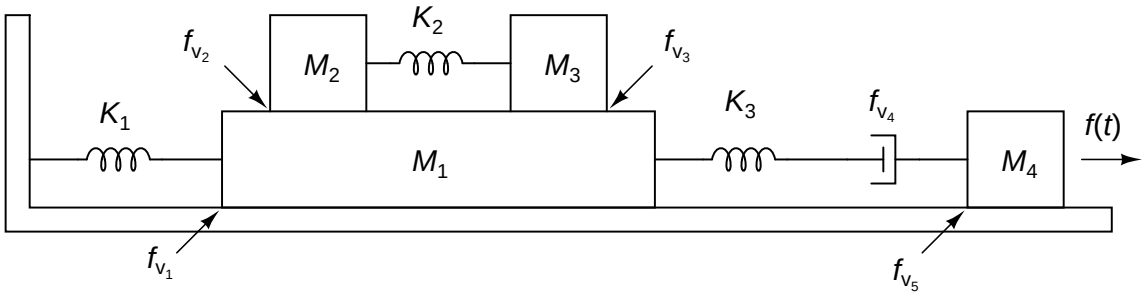
$$\frac{d^2x(t)}{dt^2} + 8\frac{dx(t)}{dt} + 41x(t) = (2t-2)u(t)$$
$$\dot{x}(0) = -1$$
$$x(0) = 3$$

Note: not *all* numbers are necessarily nice. $u(t)$ is the unit step function.

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

Problem II: [20 pts.] Translational Systems

Given the system below,

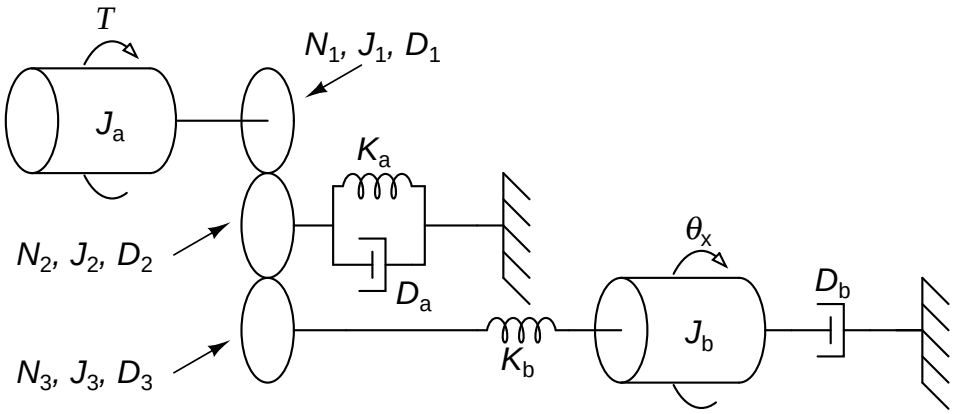


set up, but do not solve, a system of equations that could be used to find a transfer function between the position of anything in the system and the force applied to M_4. Your answer should be presented in matrix form, and you must clearly indicate what your variables mean.

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

Problem III: [20 pts.] Rotational Systems

Given the system below:

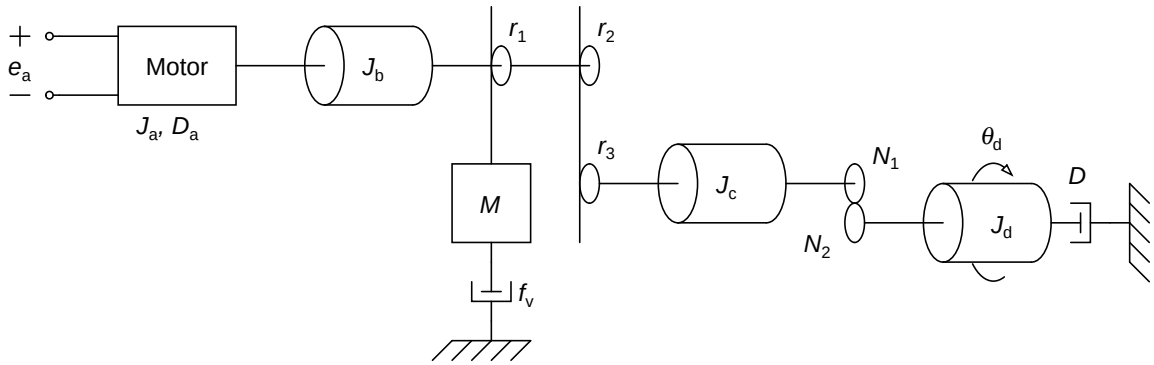


set up, but do not solve, a system of equations that could be used to find a transfer function between the angular position of anything in the system and the torque applied to J_a. Your answer should be presented in matrix form, and you must clearly indicate what your variables mean.

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

Problem IV: [20 pts.] Motorized Systems

Given the system below:



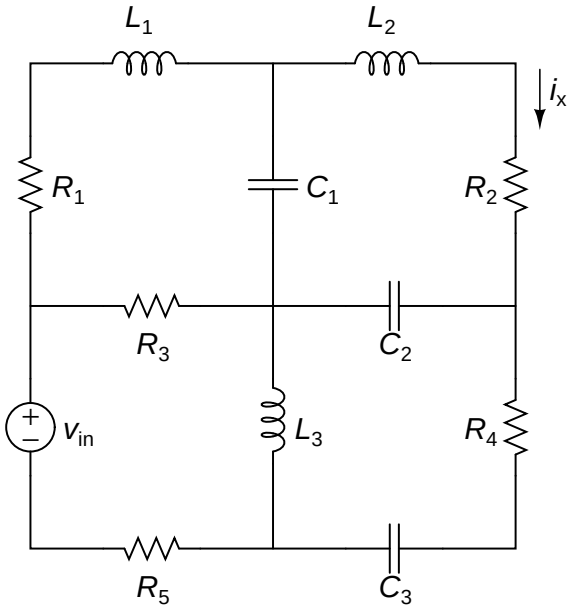
(a) Draw the equivalent system as seen by the motor, and

(b) Determine the value of the transfer function $G(s) = \Theta_d(s)/E_a(s)$. Assume that K_t, K_b, and R_a are known.

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

Problem V: [20 pts.] Electrical Systems

Given the circuit below:



set up, but do not solve, a system of equations that could be used to find a transfer function between the output current and the input voltage. Your answer should be presented in matrix form, and you must clearly indicate what your variables mean.