Your Name: _____

T&AM 203 Makeup Prelim

Monday December 6, 2004 noon - 1:30$^+$ PM

Draft December 6, 2004. From the Fall 1996 Final exam

Do any 3 problems.

Please follow these directions to ease grading and to maximize your score.

a) No ca1cu1at0rs allowed. Ask for extra scrap paper if you need it.

b) Do any 3 problems.

c) Full credit if

- work is
  - I.) neat,
  - II.) clear, and
  - III.) well organized;

± all signs and directions are well defined with sketches and/or words;

↑→ any dimensions, coordinates, variables and base vectors that you add are clearly defined;

- correct units and correct vector notation are used, when appropriate;
- to the extent that a problem seems ambiguous or not perfectly defined, you clearly state any reasonable assumptions that you make;

→| reasonable justification, enough to distinguish an informed answer from a guess, is given;

- ⟶free body diagrams⟵ (FBD's) are drawn when appropriate;
- your answers are boxed in; and
- your answers are TIDILY REDUCED.

d) Substantial partial credit if your answer is in terms of well defined variables and you have not substituted in the numerical values. Substantial partial credit if you reduce the problem to a clearly defined set of equations to solve.

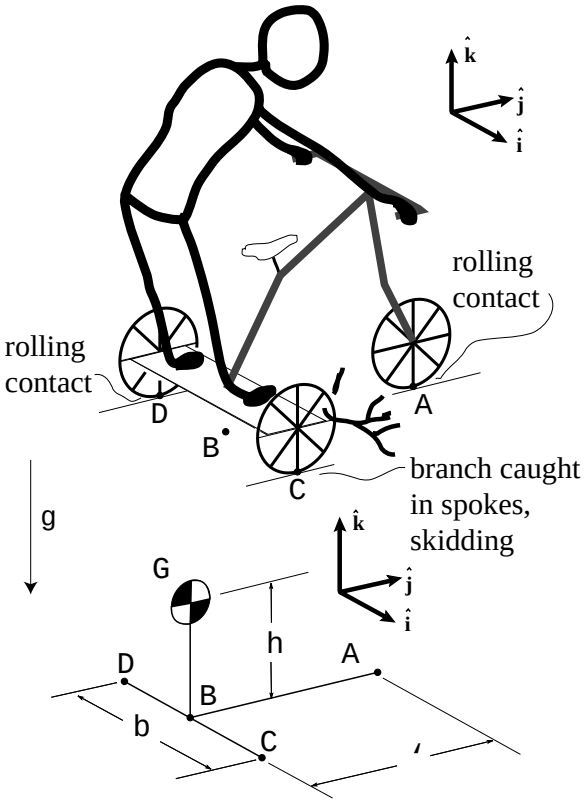
≫ MATLAB commands which would generate the desired answer count as a correct answer for all problems. *Some problems may only be only practically solvable with a computer.* You must be clear about how to interpret the MATLAB output as the answer to the question. If the problem statement is in terms of variables instead of numbers, MATLAB we will assume that the variables have been assigned values prior to the MATLAB commands you write.

Problem	1:	/25
Problem	2:	/25
Problem	3:	/25
Problem	4:	/25

1) (25 pt) Speeding tricycle gets a branch caught in the right rear wheel. A scared-stiff tricyclist riding on level ground gets a branch stuck in the right rear wheel so the wheel skids with friction coefficient μ. Assume that the center of mass of the tricycle-person system is directly above the rear axle. Assume that the left rear wheel and the front wheel have negligible mass, good bearings, and have sufficient friction that they roll in the $\hat{\mathbf{j}}$ direction without slip, thus constraining the overall motion of the tricycle. Dimensions are shown in the lower sketch.

Find the accereration of the tricycle (in terms of some or all of $\ell,\ h,\ b,\ m,\ [I^{cm}], \mu,\ g,\ \hat{\mathbf{i}},\ \hat{\mathbf{j}}$, and $\hat{\mathbf{k}}$).

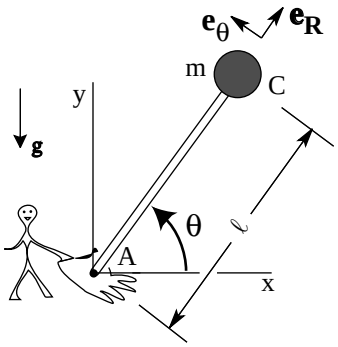
[Hint: check your answer against special cases for which you might guess the answer, such as when $\mu = 0$ or when $h = 0$.]



⇐ *Please put scrap work for problem 1 on the page to the left* ⇐.

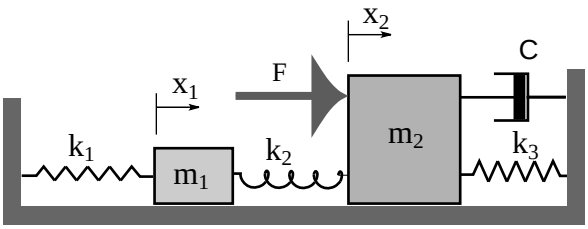
⇓ *Put neat work to be graded for problem 1 below* ⇓.

2) (25 pt) Balancing a broom. Assume the hand is accelerating to the right with acceleration $\mathbf{a} = a\,\hat{\mathbf{i}}$. What is the force of the hand on the broom in terms of m, ℓ, θ, $\dot{\theta}$, a, $\hat{\mathbf{i}}$, $\hat{\mathbf{j}}$, and g? *(You may not have any $\hat{\boldsymbol{e}}_R$ or $\hat{\boldsymbol{e}}_\theta$ in your answer.)*



⇐ *Please put scrap work for problem 2 on the page to the left* ⇐.
⇓ *Put neat work to be graded for problem 2 below* ⇓.

3) (25 pt) Equations of motion. Two masses are connected to fixed supports and each other with the three springs and dashpot shown. The force F acts on mass 2. The displacements x_1 and x_2 are defined so that $x_1 = x_2 = 0$ when the springs are unstretched. The ground is frictionless. The governing equations for the system shown can be writen in first order form if we define $v_1 \equiv \dot{x}_1$ and $v_2 \equiv \dot{x}_2$.



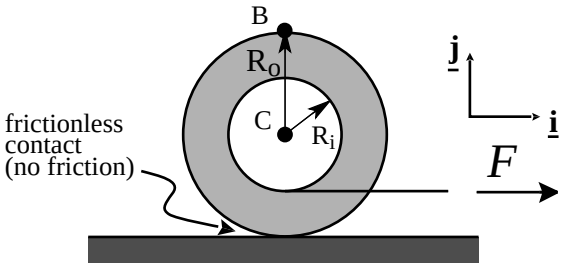
a) (10 points) Fill in the 16 terms of the 4×4 matrix below and the 4 terms of the blank column vector so that the equations are the correct equations for the system shown. Your answer should be in terms of any or all of the constants m_1, m_2, k_1, k_2,k_3, C, the constant force F, and t. Getting the signs right is important.

b) (10 points) Write MATLAB commands in appropriate functions and script files to find and plot $v_1(t)$ for 10 units of time. Make up appropriate initial conditions. If you need to use the big matrix you have defined at the bottom of the page indicate its place in your code, you need not copy it in for MATLAB term by term.

⇐ *Please put MATLAB code for problem 3 on the page to the left* ⇐.
⇓ *Put other neat work to be graded for problem 3 on this page* ⇒.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{v}_1 \\ \dot{x}_2 \\ \dot{v}_2 \end{bmatrix} = \begin{bmatrix} & & & \\ & & & \\ & & & \\ & & & \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ v_1 \\ x_2 \\ v_2 \end{bmatrix} + \begin{bmatrix} \\ \\ \\ \end{bmatrix}$$

4) (25 pt) **The film**,*Heat Treatment of Aluminum*, is placed on a very slippery table. Assume that the film and reel (together) have mass distributed the same as a uniform disk of radius R_i. What, in terms of R_i, R_o, m, g, $\hat{\mathbf{i}}$, $\hat{\mathbf{j}}$, and F are the accelerations of points C and B at the instant shown (the start of motion)?



⇐ *Please put scrap work for problem 4 on the page to the left* ⇐.
⇓ *Put neat work to be graded for problem 4 below* ⇓.