Your TA, Section # and Section time:

Your name:

Cornell TAM/ENGRD 2030

Makeup Prelim

May 4, 2013

No calculators, books or notes allowed.

3 Problems, 90 minutes (+ up to 90 minutes overtime)

How to get the highest score?

Please do these things:

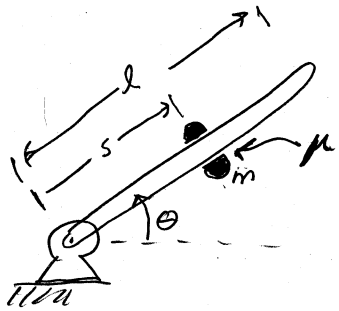
- Draw **Free body diagrams** whenever force, moment, linear momentum, or angular momentum balance are used.
- Use correct **vector notation**.
- A+ Be (I) neat, (II) clear and (III) well organized.
- TIDILY REDUCE and box in your answers (Don't leave simplifyable algebraic expressions).
- >> Make appropriate `Matlab code` clear and correct.
  You can use shortcut notation like "$T_7 = 18$" instead of, say, "`T(7) = 18`".
  Small syntax errors will have small penalties.
- Clearly **define** any needed dimensions ($\ell, h, d, \ldots$), coordinates ($x, y, r, \theta \ldots$), variables ($v, m, t, \ldots$), base vectors ($\hat{\imath}, \hat{\jmath}, \hat{\boldsymbol{e}}_r, \hat{\boldsymbol{e}}_\theta, \hat{\boldsymbol{\lambda}}, \hat{\boldsymbol{n}} \ldots$) and signs ($\pm$) with sketches, equations or words.
- **Justify** your results so a grader can distinguish an informed answer from a guess.
- If a problem seems *poorly defined*, clearly state any reasonable assumptions (that do not oversimplify the problem).
- ≈ Work for **partial credit** (from 60–100%, depending on the problem)
  - Put your answer is in terms of well defined variables even if you have not substituted in the numerical values.
  - Reduce the problem to a clearly defined set of equations to solve.
  - Provide Matlab code which would generate the desired answer (and explain the nature of the output).
- **Extra sheets.** Ask for more extra paper if you need it. Put your name on each extra sheet.

Problem 10: ____/25

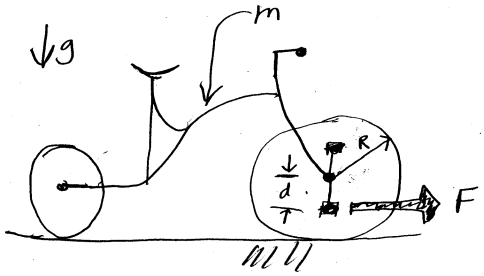
Problem 11: ____/25

Problem 12: ____/25

10) 2D. No gravity. A bead m slides with friction coefficient μ on a rigid straight rod with length ℓ that is rotated by a motor. At the instant of interest the angle of the rod is θ, the rotation rate is $\dot{\theta}$ and the angular acceleration is $\ddot{\theta}$. The bead is a distance s from the motor axle and has rate of sliding $\dot{s} > 0$. In terms of some or all of $\mu, \theta\dot{\theta}, \ddot{\theta}, \ell, s$ and $\dot{s}$, find $\ddot{s}$.



11) 2D. A tricycle has weight mg and wheels with negligible mass. The steering is locked straight forwards. Assume the friction μ is big enough so that the wheels roll without slip. The front wheel has radius R and the front crank has length $d < R$. A forwards force $F > 0$ is applied to the bottom pedal from a person standing at the side. In terms of some or all of m, g, R, d, F, μ and g, which direction does the tricycle accelerate (right or left) and with what acceleration?



12) Write all of the Matlab commands to solve the following problem using ODE23 or ODE45. The result should be printed by Matlab in the command window.

The equation of a damped simple pendulum is $\ddot{\theta} = -\frac{g}{\ell}\sin\theta - c\dot{\theta}$.

Find the angle θ at $t = t_f$.

Use any non-zero values you like for g, ℓ, c and t_f and for the initial conditions.