Your TA, Section # and Section time:

Your name:

Cornell TAM/ENGRD 2030

No calculators, books or notes allowed.

5 Problems, 150 minutes (no extra time)

Final Exam

May 12, 2011

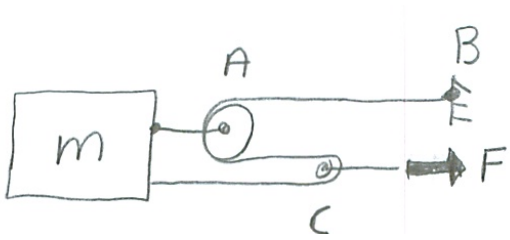
How to get the highest score?

Please do these things:

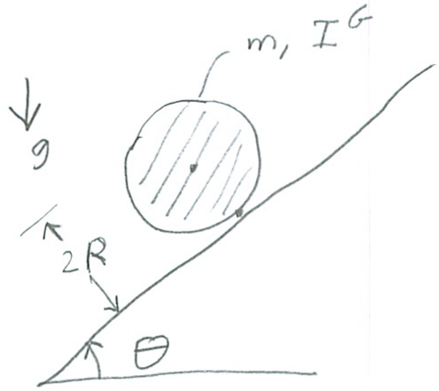
- Draw **Free body diagrams** whenever force, moment, linear momentum, or angular momentum balance are used.
- Use correct **vector notation**.
- A+ Be (I) neat, (II) clear and (III) well organized.
- ◻ TIDILY REDUCE and box in your answers (Don't leave simplifyable algebraic expressions).
- >> Make 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 ($\hat{\boldsymbol{\imath}}, \hat{\boldsymbol{\jmath}}, \hat{\boldsymbol{e}}_r, \hat{\boldsymbol{e}}_\theta, \hat{\boldsymbol{\lambda}}, \hat{\boldsymbol{n}} \ldots$) 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.** Put your name on each extra sheet, fold it in, and refer to it at the relevant problem.
  Note the last page is **blank** for your use. Ask for more extra paper if you need it.

Problem 13:	/25
Problem 14:	/25
Problem 15:	/25
Problem 16:	/25
Problem 17:	/25

13) Making all the usual assumptions about masses and pulleys, find the acceleration of point C in terms of F and m. Neglect gravity.



14) A disk rolls down a ramp without slipping. How big does μ have to be in order to prevent slip? (That is, if μ is too small, slip would not successfully be prevented). Answer in terms of some or all of θ, g, R, I^G and m.

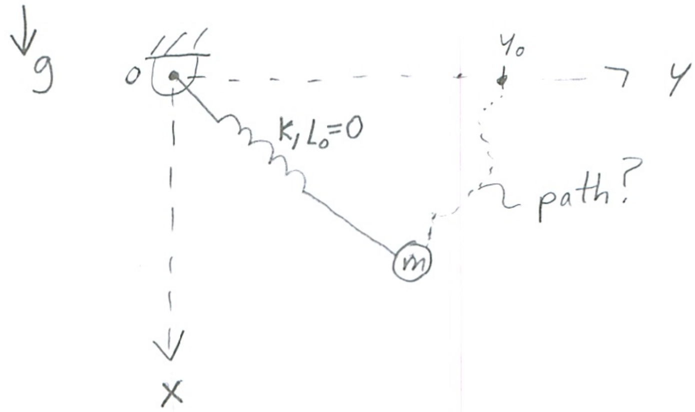


15) A mass m hangs from a spring with constant k and rest length $L_0 = 0$ (the spring is a so-called zero-rest-length spring). The mass is released from rest at the position $\vec{r}_0 = 0\hat{\imath} + y_0\hat{\jmath}$.

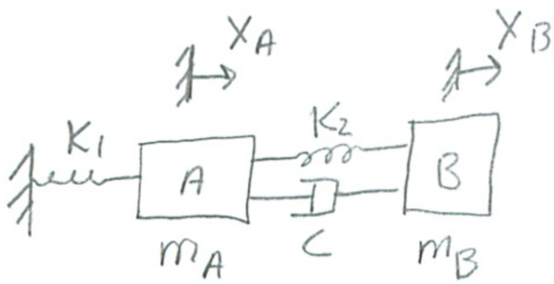
a) Find the position of the mass at time t in terms of some or all of k, m, g and y_0.

b) Draw the trajectory (the path that the mass moves on).

c) In words, describe the shape of the trajectory.



16) Write MATLAB commands to make a plot of $x_B(t)$. Pick any convenient non-zero values (in consistent units) for any variables or constants.



17) A motor at O turns a rigid rod OA (mass M, moment of inertia I^G) at constant angular rate $\dot{\phi}$. A negligible-mass rod with length r is hinged at A and has mass m at its end. Neglect gravity.

a) Is angular momentum of the system OAB about O constant or not? (Explain your answer.)

b) Consider the special case that $\phi = 0$ and $\dot{\phi} = 0$ (for all time). Find $\ddot{\theta}$ in terms of as many of these terms are needed: θ, $\dot{\theta}$, L, L_G, r, M, m and I^G.

c) Now consider non-zero $\dot{\phi}$. Find $\ddot{\theta}$ in terms of some or all of ϕ, $\dot{\phi}$, θ, $\dot{\theta}$, L, L_G, r, M, m and I^G.