****Please write your net ID and name on the top of every side of every page, now.****
—Please print clearly (for computer text recognition)—

U-grad or M-Eng or PhD? & 4730 or 5730? **Your netID (xyz*lmn*) & name:**

Cornell ME 4730/5730

Prelim 2

Sunday Nov. 8, 2020, 4-5:30 PM^{+}

No calculators, books or notes allowed.

3 Problems, 90 minutes (+ 90 minutes extra time)

How to get the highest score?

Please do these things:

Scans. Start each problem on a clean sheet.
Put ***your name, *net ID, *problem number** and ***page number** on the top of every side of every sheet.
At the end:
—Scan your exam, including both sides of this sheet,& check it for completeness and quality;
—Filename should be netID-first-last.pdf (*e.g.,* alr3-Andy-Ruina.pdf);
—Subject: "Prelim 1";
—email it to: ruina@cornell.edu;
—Check that it has been received before leaving the exam;

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 "$\phi_7 = 2\pi$" instead of, say, "`phi(7) = 2*pi;`".
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 you quote a fact that a grader might doubt your understanding of, explain it. Especially if it is not commonly used.

If a problem seems *poorly defined*, clearly state any reasonable assumptions (that do not oversimplify the problem).

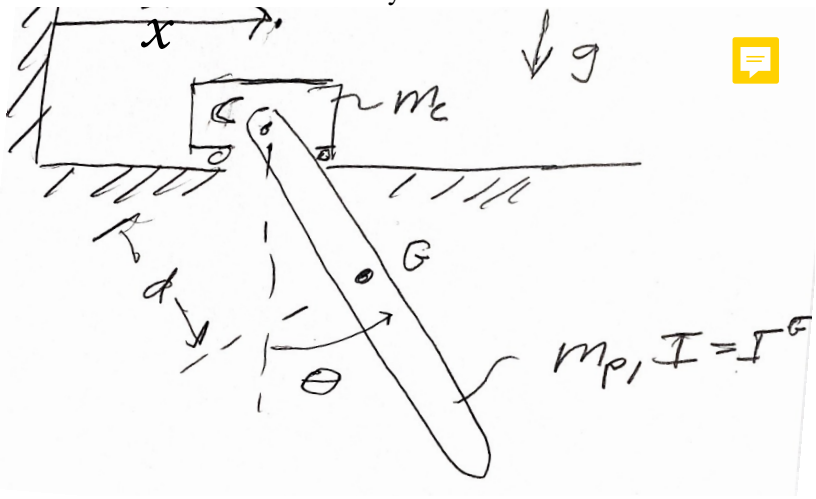
≈ Work for **partial credit** (from 60–100%, depending on the problem)

- 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 (unless specifically precluded).

Extra sheets. Ask for more extra paper if you need it. Put your name, net ID, problem number and page number on each extra sheet, label it clearly place it in order with it's associated problem.

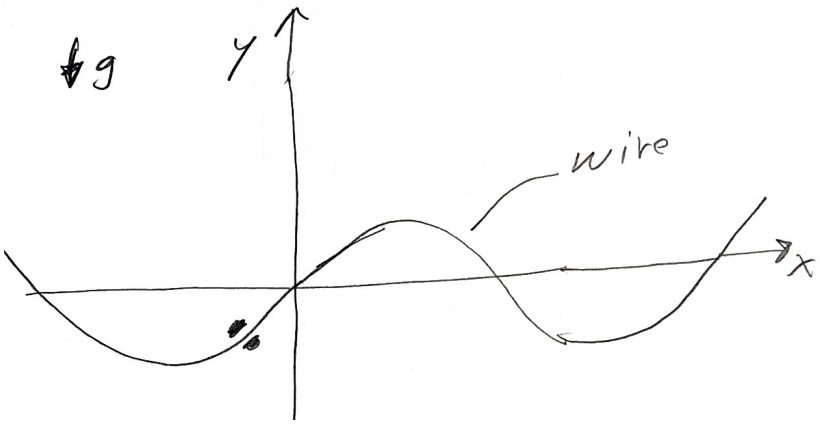
All problems are 2D.

1) Cart and pendulum. 2D. There is gravity. A pendulum hangs from a freely rolling cart. At a given instant (just one instant in time) you want to know the force $\vec{F}_C$ (a vector) on the pendulum from the cart at A. Matlab code has already been written that assigns numerical values to all mass and length parameters as well as to $x_C, v_C = \dot{x}_C, \theta$ and $\omega = \dot{\theta}$. Write MATLAB code, the last line of which gives a two component vector for $\vec{F}_C$. Define any coordinates or intermediate variables that you use.



vfill

2) Bead on wire. 2D. There is gravity g. A bead with mass m slides without friction on a rigid slippery wire. The shape of the wire is $y = A\sin(cx)$. Given $x, \dot{x}, m, g, A$ and c, find $\ddot{y}$. You can do this with pencil and paper or write MATLAB code that would give you the answer.



3) Two particles. 2D. Two particles m_1 and m_2 are connected by a rigid massless rod. A known and given external force $\vec{F}(t)$ acts on m_1. Write the equations of motion using the DAE approach, clearly defining any matrices or column vectors you define.