****On the top of every page, write the following****
—Please print clearly (for computer text recognition)—

Your netID (xyz*lmn*) **&** **name**	Problem number and page number of that problem

Cornell ME 2030 Prelim 3

No calculators, books or notes allowed.

Thursday May 6, 2021, 6:30 - 8 PM$^+$

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

How to get the highest score?

Please do these things:

PDF scans: Start each problem on a clean sheet. Only write on one side.
Put ***your name, *net ID, *problem number** and ***page number, starting with 1 for each problem** on the top of every side of every sheet.

At the end: — Scan your 3 exam problems to 3 pdf files; check them for completeness and quality; only one (possibly multi-page) file per problem
— Filenames should be your netID-problem number (e.g., alr3-2.pdf)
— Upload each problem separately to Canvas — Check on Canvas that all three problems have 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 simplifiable 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)

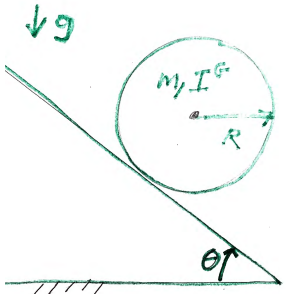
- Put your answer is in terms of well defined variables even if you have not substituted in the numerical values.
- Reduce the problem to a clearly defined set of equations to solve.
- Provide Matlab code which would generate the desired answer, and explain the nature of the output (unless specifically precluded).

Extra sheets. If live, 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.

7) Disk on ramp. At $t = 0$ a disk is released from rest (no velocity, no angular velocity) on a ramp, as shown. The coefficient of friction between the disk and ramp is μ (Alternatively, if convenient for you, you can characterize the friction using the friction angle ϕ_f, defined as: $\tan(\phi_f) = \mu$).

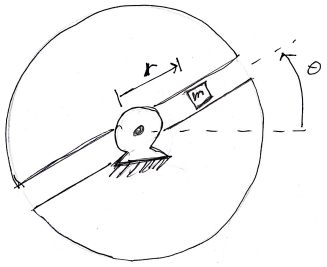
a) Assuming friction is such that there initially *is* slip, for how long does slip last? You can answer either "How much time until rolling?" or "For what distance down the ramp until rolling?", your choice. Answer in terms of some or all of m, I^G, R, θ, g and μ (or, ϕ_f).

b) In contrast, for what values of μ (or, ϕ_f) does the disk roll without slip at the start of the motion? Answer in terms of some or all of m, I^G, R, θ and g.



8) Bead in slot. Neglect gravity. A motor turns a turntable at constant rate ω, with amount of net rotation = $\theta = \omega t$. A bead (mass = m) slides in a slot and rubs on one side of the slot or the other with coefficient of friction μ. At the start, the bead is released at $r = R_1 > 0$ and has no radial velocity. The bead then spirals out to ∞. On the way it passes by $r = R_2 > R_1$. The disk is so large (much larger than the drawing) that the bead never gets to the outer edge

• Find the total work done by the motor in the time from when the disk starts at R_1 and gets to R_2. Answer in terms of some or all of ω, m, μ, R_1 and R_2.



9) Block with springs. A uniform square plate (sides L, mass m, moment of inertia I^G) is suspended by two identical springs (spring constant = k). It is in equilibrium.

a) Then, spring CD is cut. Immediately after the cut, find the acceleration (a vector) of point H. Answer in terms of some or all of m, I^G, L, g, k and $\hat{\imath}$ & $\hat{\jmath}$.

b) Calculate I^G in terms of m and L.