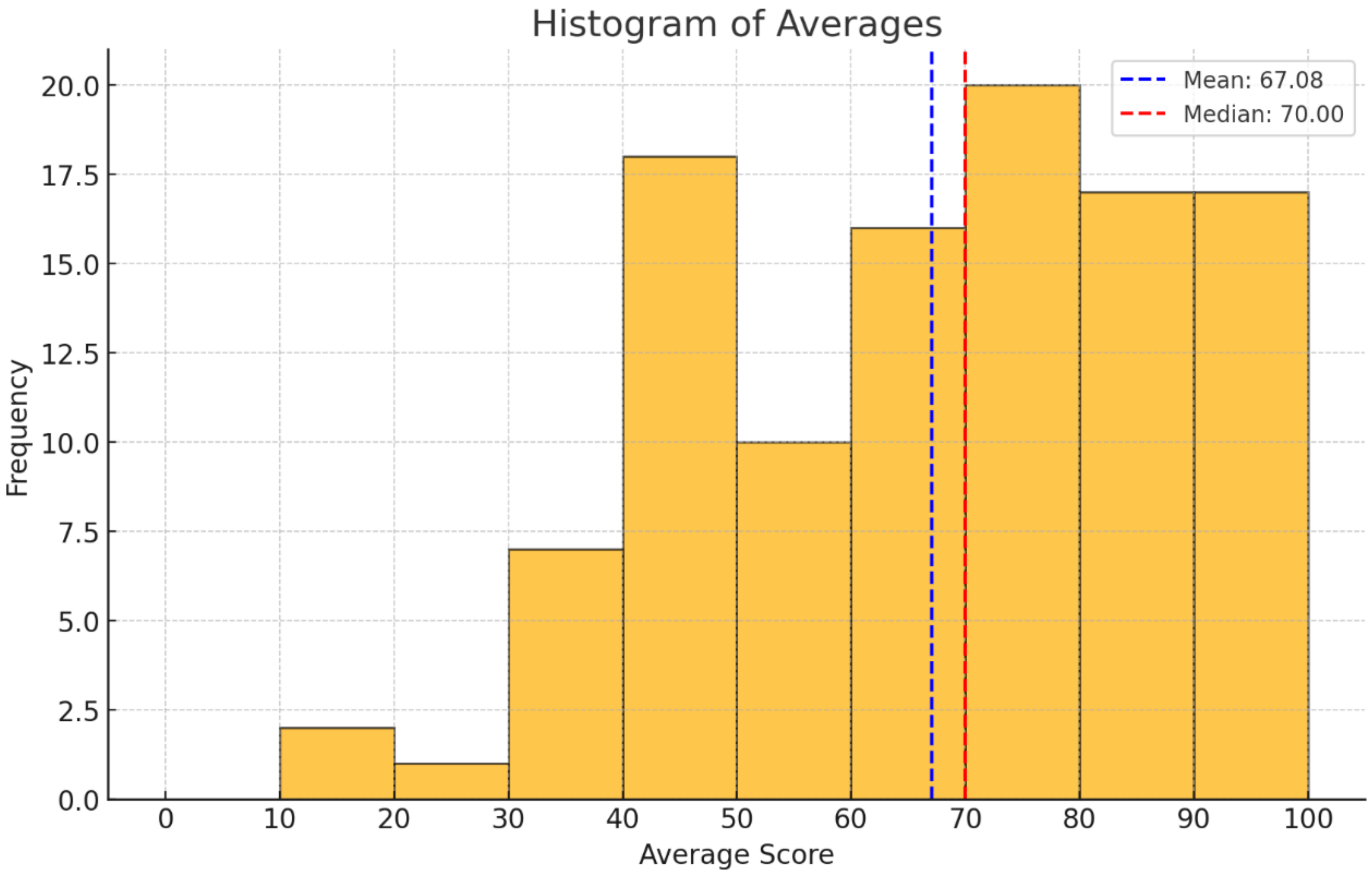
SQUARECAP

Thoughts on the Exam?

How are your other courses going?

Recap: Exam II



- Median Score: ~**70**
- With redo and rescore:

→Median ~**85**%,

- Redos will be due before final exam
- Additional motivation: zombie problem!

Recap: Exam II

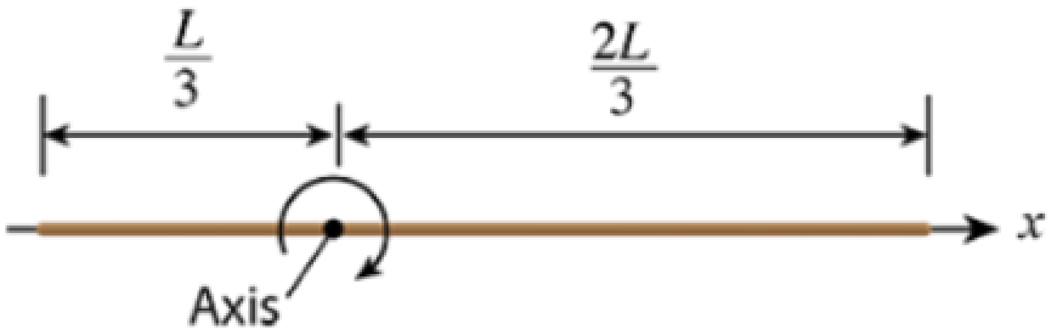
- Zombie Problem: The pole vaulter – Great work!

Recap: Exam III

Problem 5 - 10.5.12 :

The diagram shows a uniform rod of mass M and length L, where the axis of rotation is a distance of $\frac{L}{3}$ from one end.

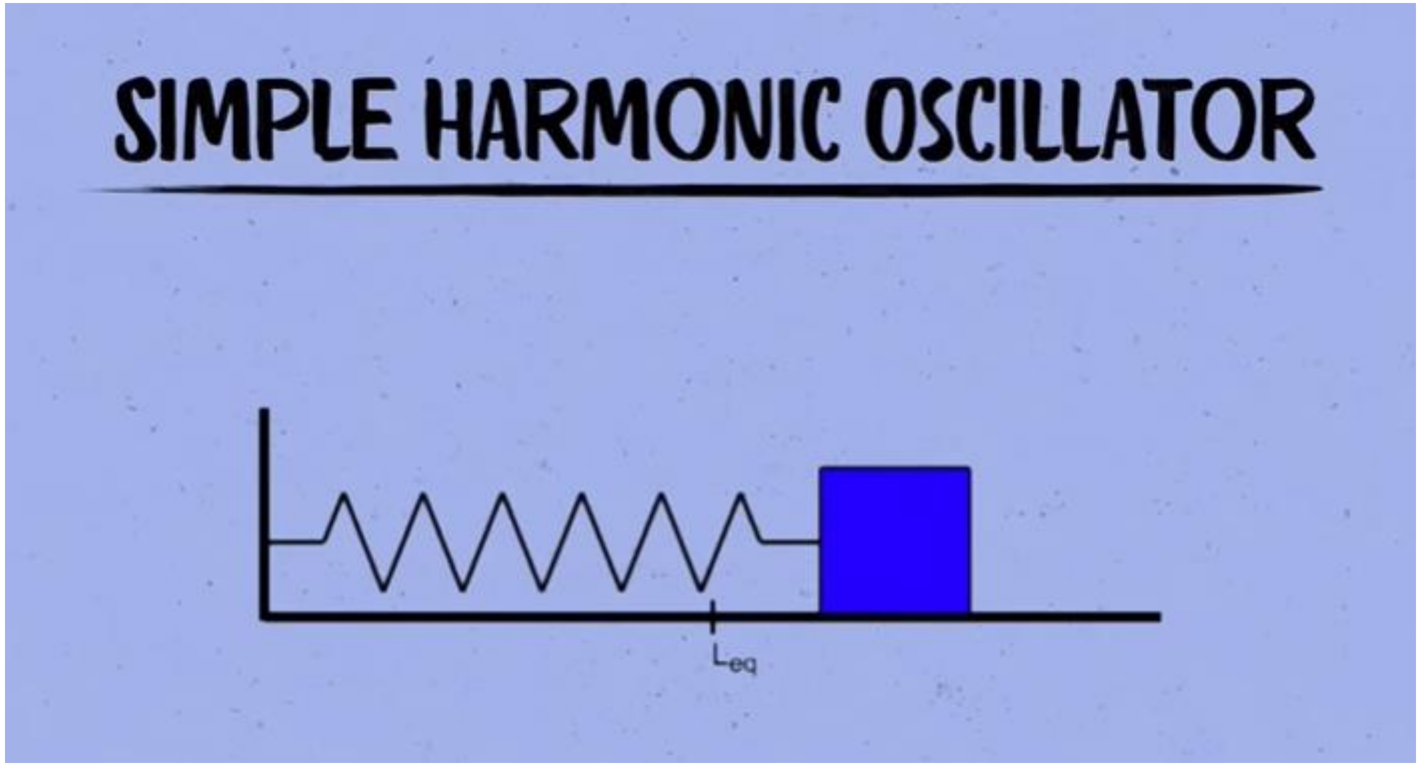
Part (a) **Determine an expression for the moment of inertia of the rod.**



Notes

- Just one more homework on oscillations/waves/sound, due the last day of class (Monday, Dec 9)

Prelecture Review: Small Oscillations



Energy near an equilibrium:

$$U \approx U_0 + \frac{1}{2}kx^2 + \cdots$$

Oscillations:

$$\ddot{x} = -\omega^2 x$$

Natural Frequency

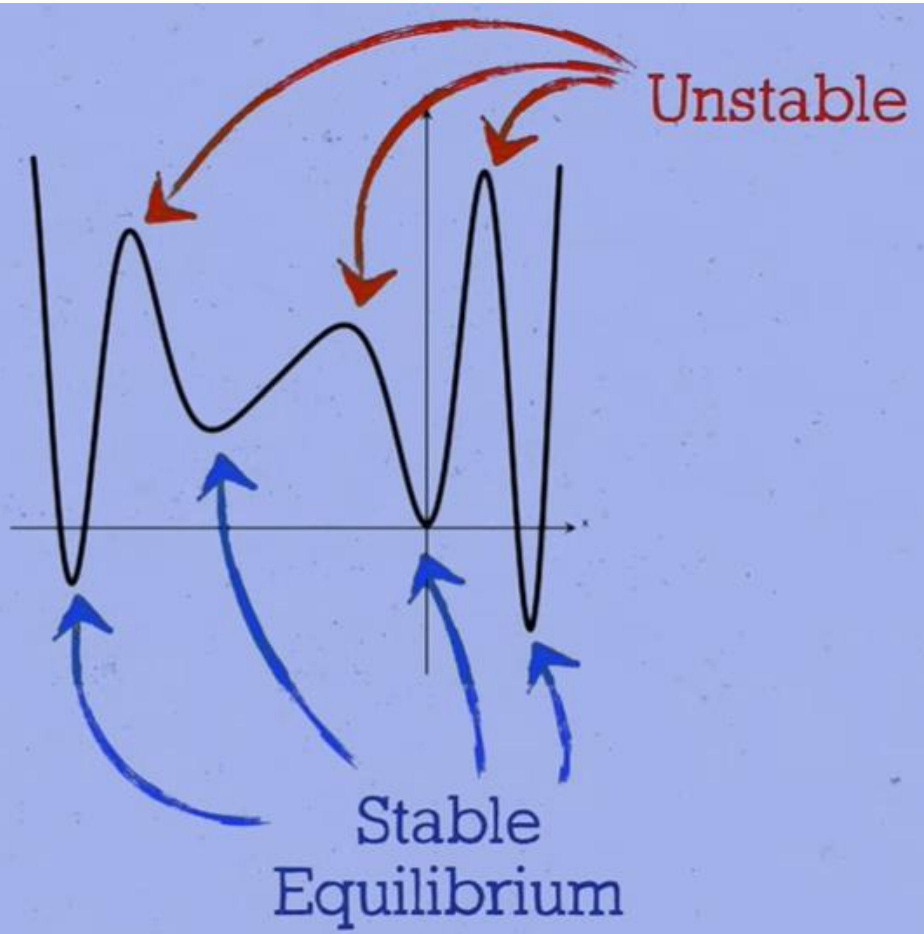
$$\omega = \sqrt{\frac{k}{m}}$$

$$x(t) = A\cos\omega t + B\sin\omega t$$

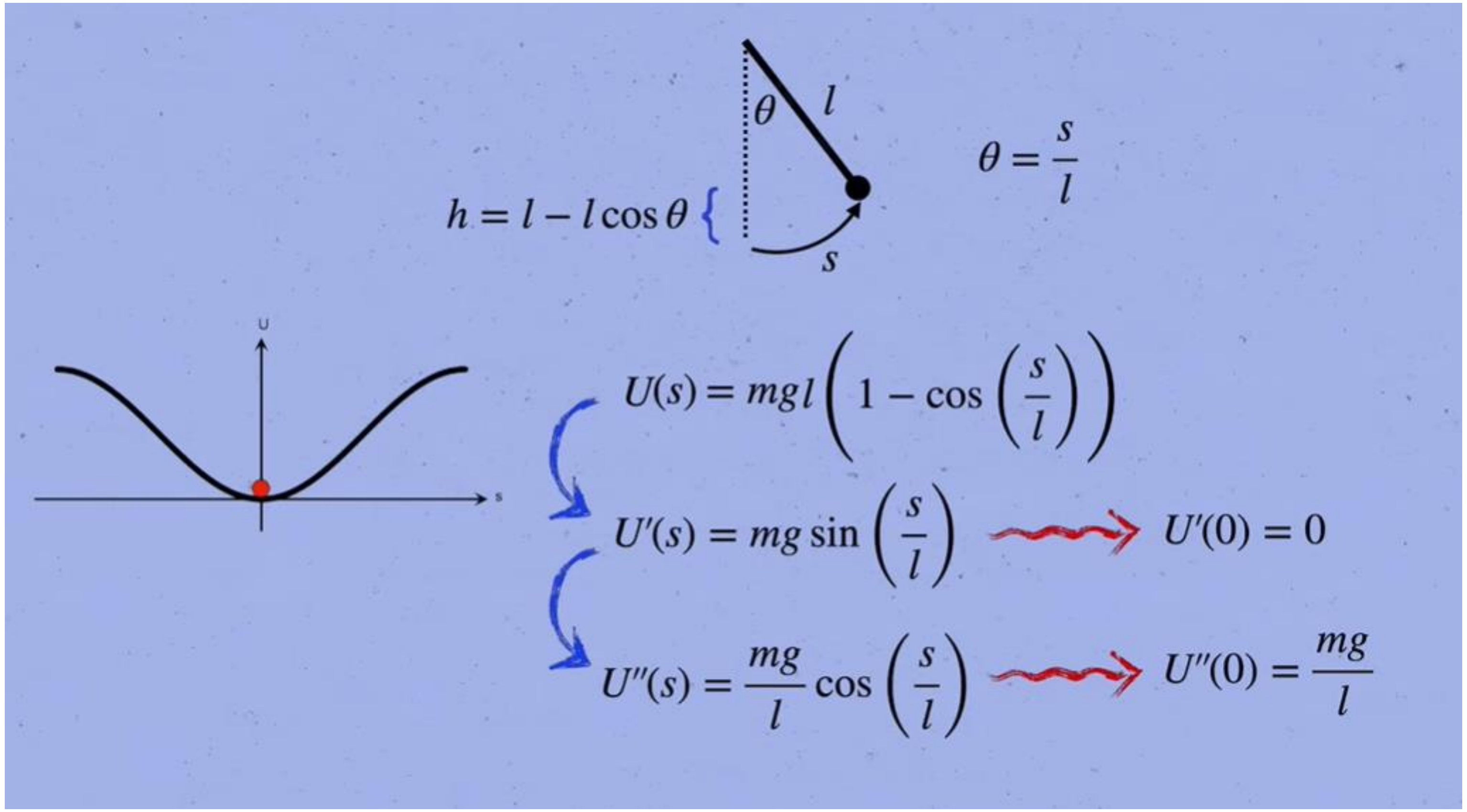
$$x(t) = A\cos(\omega t + \phi)$$

What are our comments and questions?

$$m\frac{\mathrm{d}^2x}{\mathrm{d}t^2} = -\frac{\mathrm{d}U}{\mathrm{d}x} \rightsquigarrow x(t) = \cdots$$



Example: Pendulum



$$U(s) \approx \frac{1}{2}U''(0)s^2$$

$$k = \frac{mg}{l}$$

$$\Omega = \sqrt{\frac{g}{l}}$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$g\left(\frac{T}{2\pi}\right)^2 = l?$$

Comments and Questions

- What I wonder is if that harmonic oscillating pattern applies for all angles, or up to a certain angle.
- Does hookes law explain why the earth spins in an elipse instead of a perfect circle?
- How would the behavior of the system change if we were to include damping forces, such as friction, and how would this affect our understanding of small oscillations in both classical and quantum contexts?
- I'm confused by the introduction of sin and cos from omega squared; does this come from the pythagorean theorem or a different trig identity?

My comments and Questions

- Comment: “Empty” space in our universe is near equilibrium. Particles are, in some sense, oscillations of fields about this equilibrium in the same way.

- Question: How can we describe systems that a far from equilibrium? We have to go beyond approximations like Taylor series, which is challenging.

Discuss and Answer:

What will happen if the pendulum is given a tangential velocity (See board). What path will it traverse? What/will there be an associated period?

Example

Problem 5 - 13.1.14 :

A section of uniform pipe is bent into an upright U shape and partially filled with water, which can then oscillate back and forth in simple harmonic motion. The inner radius of the pipe is r = *0.011* m. The radius of curvature of the curved part of the U is R = *0.15* m. When the water is not oscillating, the depth of the water in the straight sections is d = *0.21* m.

Part (a) **Enter an expression for the mass of water in the tube, in terms of the defined quantities and the density of water, ρ. Use the approximation $r \ll R$.**

Part (b) **Calculate the mass of the water, in kilograms. Take $\rho = 1000\ \text{kg/m}^3$.**

Part (c) **Enter an expression for the force constant of the U-shaped column of water when displaced from equilibrium, in terms of the defined quantities, ρ, and g. This constant is analogous to the spring constant in Hooke's law.**

Part (d) **Find the value of the force constant, in newtons per meter. Take $\rho = 1000\ \text{kg/m}^3$ and $g = 9.81\ \text{m/s}^2$.**

Part (e) **Calculate the period of oscillation, in seconds.**