PHYS-3203 Homework 6 Due 29 Feb 2024

This homework is due to `https://uwcloud.uwinnipeg.ca/s/Re9qoZBqcD8F5oe` by 10:59PM on the due date. Your file(s) must be in PDF format; they may be black-and-white scans or photographs of hardcopies (all converted to PDF), PDF prepared by LaTeX, or PDF prepared with a word processor *using an equation editor*.

1. **Steady Precession of a Top** *related to question from Thornton & Marion*

   Consider a symmetric top that is initially spinning vertically $\theta = 0$, so the two conserved angular momenta p_ϕ and p_ψ as defined in the notes equal each other.

   (a) Write the effective potential $U(\theta)$ for motion in θ and expand it to order θ^2.

   (b) Based on your expansion above, under what conditions is rotation with $\theta = 0$ stable? Compare this to our discussion of steady precession in the lecture notes. *Hint:* Is $\theta = 0$ an extremum? If so, what kind?

   (c) Suppose that $2MgRI < p_\psi^2 < 4MgRI$. By considering the value of $U(\theta)$ at $\theta = 0$ and $\theta = \pi/2$ and the result of the previous part, argue that the top nutates between $\theta = 0$ and another angle $\theta_1 < \pi/2$.

   (d) Find $\dot{\phi}$ and $\dot{\psi}$ when $\theta = 0$. Under what condition does $\dot{\psi}$ have the opposite sign of p_ψ for $\theta = 0$? (When this occurs, the top spins in the opposite direction of the precession.)