Stellar - HW6
October 9, 2025, Due October 17, 2025
2 pt each part

1) a) What is the maximum stellar mass? Compute the Eddington luminosity by assuming $\bar{\kappa} = \kappa_{es}$ and $X = 0.7$, and use an appropriate mass-luminosity relation for high masses. You'll have to look up the electron (Thompson) scattering opacity.
b) (1 pt) If we add in other sources of opacity, would the maximum mass increase or decrease?

2) (10 pt) Compute the density profile for the $n = 0, 1, 1.5, 3$, and 5 polytropes. Although some of these can be solved analytically, you'll want to use the same code for all. Spreadsheets could work if you're not comfortable coding. And as always I'm here to help.

Start with the Lane-Emden equation. This is a second-order differential equation, but we can write second-order equations as two first-order equations, one of which is the derivative of the function that you are trying to solve. In other words, define a new function as the derivative $f(\xi) \equiv d\theta/d\xi$ and then solve for $df(\xi)/d\xi$. You can then compute $\theta(\xi)$ and $f(\xi)$ using Euler's method.

Please plot these density profiles on a single set of axes for all n; put ρ/ρ_c on the y-axis and ξ on the x-axis. Please turn in both the plot and the code.

3) (Grad students only) You are observing an external galaxy that lies at some Galactic latitude b. Adopting a simple slab model of the interstellar medium for our Galaxy, show that the optical depth caused by our Galaxy is proportional to cosec $|b|$. If $\tau = 1$ for an observation at the north Galactic pole. How much extinction would you expect for an observation of a galaxy at $b = 30°$. Hint: draw a picture!

4) (Grad students only) The maximum mass of a (non-rotating) white dwarf is 1.4 $M_\odot$ (for Solar abundance).
a) How fast would it need to be rotating for the maximum mass to be 50% higher?
b) Assuming the Solar core is rotating at the same speed as what we observe for the Sun's equator, what is the maximum mass for the white dwarf that will be formed from the Sun?