AST383D (Fall 2005)

STELLAR STRUCTURE AND EVOLUTION

Problem Set 3

Due Tuesday, November 22, 2005

(worth 20/100)

1. Polytropic Stellar Models

a. Numerically solve the Lane-Emden equation for index $n = 1.5$ and $n = 3$. Determine the value for the dimensionless radius ξ_n, and evaluate the expression $(-\xi^2 \frac{d\Theta}{d\xi})_{\xi_n}$ (i.e., at the surface).

b. Plot $\Theta(\xi)$ vs. ξ for both n (on the same plot).

2. Simple Model for the Sun

Experience shows that the structure of the Sun can approximately be described with an $n = 3$ polytrope. Use your results from part 1 to construct such a model.

a. What is the central density ρ_c (in g cm^{-3})? Determine the numerical value of A in $\xi = Ar$. (Hint: Evaluate this expression at the surface of the Sun.) Find the value of K in $P = K\rho^{1+1/n}$. (Hint: Look up your Lecture Notes.) What is the central density P_c (in dyne cm^{-2})? Using the ideal gas law (with $\mu \simeq 0.6$), what is T_c? How do P_c, ρ_c, T_c compare with the results from more sophisticated calculations?

b. Plot P (in dyne cm^{-2}) and ρ (in g cm^{-3}) vs. radius r (in cm).