Mid-Term Exam

1. Which lives longer — a B star or a G star? Justify your answer.
2. Balmer hydrogen lines are not seen in the spectra of either O stars or K stars. Why not?
3. What source of opacity
   (a) Is independent of wavelength?
   (b) Is strongly peaked around a specific wavelength?
   (c) Is non-zero only at wavelengths shorter than a specific wavelength?
4. What does the effective temperature of a star measure?
5. The star Capella (α Aurigae) has an apparent visual magnitude $V = 0.71$ and an absolute visual magnitude $M_V = 0.14$.
   (a) Calculate the star's distance and parallax.
   (b) The bolometric flux from Capella, measured on Earth, is $F_{\rm bol} = 1.5 \times 10^{-5}\,{\rm ergs\,cm^{-2}\,s^{-1}}$. Calculate the star's bolometric luminosity in solar units.
   (c) Analysis of Capella's spectrum indicates an effective temperature $T_{\rm eff} = 5,300\,{\rm K}$. Assuming that the spectrum can be approximated as a blackbody, at what wavelength is the flux at a maximum?
   (d) From the width of its spectral lines, the surface gravity of Capella is determined as $g = 700\,{\rm cm\,s^{-2}}$. Calculate the star's radius and mass in solar units.
   (e) Is Capella a main-sequence star? Justify your answer.
   (f) Capella has a binary companion in a circular orbit, with a period $P = 0.284\,{\rm yr}$ and a semi-major axis $a = 1.1 \times 10^{13}\,{\rm cm}$. Calculate the mass of the companion in solar units.
6. Consider a plane-parallel gray atmosphere, where the radiation field is represented by the two-stream Schuster model

$$I(\tau_{\rm v},\mu) = I_+(\tau_{\rm v})\delta\left(\mu - \frac{1}{\sqrt{3}}\right) + I_-(\tau_{\rm v})\delta\left(\mu + \frac{1}{\sqrt{3}}\right).$$

   (here, δ is the Dirac delta function). Demonstrate that the Schuster model satisfies the Eddington approximation.