BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2017-2018

Mid-Semester Exam Part-A (Closed Book)

Course No: PHY F215 Course Title: **Introduction to Astronomy & Astrophysics** Date: 05.03.2018

Max. Time: 50 min. Total Marks: 50

---

1. Hydrostatic Equilibrium [15 Marks]

Dervie the equation of Hydrostatic equilibrium inside stars. Assume stars are spherical objects and only pressure and gravity are important in maintaining the equilibirum. Using this equation, make a crude estimate for the pressure at the center of the Sun.

2. Radiation From Optically Thick and Optically Thin Gas [15 Marks]

Consider a horizontal, plane parallal slab of gas of thickness L, maintained at a constant temperature T. When looking at the slab from above, when no radiation enters the gas from outside, what do you see when,

(a) the optical depth of the base of the layer is very large (optically thick)?

(b) the optical depth of the base of the layer is very small (optically thin)?

You may make the following assumptions:

1. *Source function does not vary with position in gas.*
2. *Thermodynamic equilibrium when* $\tau_\lambda \gg 1$.
3. *Optical depth at the top surface of the slab is 0.*

If you make any additional assumptions, state them clearly.

3. Mean Free Path and Average Time Between Collisions [10 Marks]

(a) Estimate the mean free path of the nitrogen molecules in your classroom at room temperature (300 K).

(b) Using the root-mean-squared speed, calculate the average time between collisions of the molecules.

Take the radius of a nitrogen molecule to be 0.1 nm and the density of air to be 1.2 kg m^{-3} *. A nitrogen molecule contains 28 nucleons (protons and neutrons).*

4. Fraction of Ionized Hydrogen at the center of Sun [10 Marks]

What fraction of hydrogen atoms are ionized at the center of the Sun? Assume that the temperatute at the center of the Sun is 15.7 million K and the number density of electrons, n_e=6.0 X 10^{31} m-3. Use ZI = 2.

----------END OF CLOSED BOOK----------

A

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2017-2018

Mid-Semester Exam Part-B (Open Book)

Course No: PHY F215 Course Title: **Introduction to Astronomy & Astrophysics** Date: 05.03.2018

Max. Time: 40 min. Total Marks: 40

---

1. Two identical stars are moving in a circular orbit around one another with an orbital separation of 2 AU. The system lies approximately 200 light years from Earth. If we happen to view the orbit face-on, how large a telescope would we need to resolve the stars assuming diffraction limited optics at a wavelength of 2 micron? [4]

2. A certain telescope has a 10' X 10' field of view that is recorded using a CCD chip having 2048 X 2048 pixels. What angle on the sky corresponds to 1 pixel? [4]

3. Sun is approximately at 8 kpc from the center of the Milky Way Galaxy. Assume that it moves in a circular path with a velocity 220 km s^{-1}. Estimate the approximate mass of the Galaxy. [5]

4. Suppose there is a star with a radius ten-times that of the Sun, and luminosity 500-times that of the Sun, what is the temperature of the star? Assume the star is also a main-sequence star. [4]

5. At a certain wavelength, a medium with a specific intensity of 6.7 X 10^{-5} W m^{-2}ster s^{-1} A^{-1} is seen in front of a body with a source function 2.5 X 10^{-4} W m^{-2}ster s^{-1} A^{-1}. The observed intentisy is 1.88 X 10^{-4} W m^{-2}ster s^{-1} A^{-1}. What is the optical depth of the medium at this wavelength? [4]

6. At a certain frequency the absorption coefficient of air is 0.25 kg/m^3 of air. The density decreases exponentially with height as $\rho = 1.2 e^{\frac{-h}{10000}}$ where ρ is in kg/m^3 and h is in meters. What is the optical depth of vertical incidence? [4]

7.In a star of total mass M, density decreases from the center to the surface as a function of r given as,

$\rho = \rho_c [1 - (\frac{r}{R})^2]$ where ρ_c is a given constant and R is star's radius. What is M(r)? [4]

8. Which kind of opacity is the major source of opacity in hot stars, cool stars, and intermediate stars? Why? State your reason in brief. [4]

9. What is the distance to a K0 star of luminosity Class V if it has an apparent magnitude V=12? [4]

10. State true or false:

(a) There is perfect correspondence between spectral type and temperature.

(b) When we are imaging moon using any telescope, we are measuring flux and not specific intensity.

(c) Adaptive Optics allow us to reach diffraction limited resolution. [3]