Name of the Department: Department of Physics and Astrophysics

Name of Course: B.Sc. Hons. Physics-CBCS_DSE

Name of the Paper: Astronomy & Astrophysics

Semester : V

Unique Paper Code: 32227506

Question paper Set number: Set A

Max Marks : 75 Time: 3Hrs

Attempt any four questions. All questions carry equal marks

Q1. (a) Define circumpolar stars. With the help of a suitable diagram show that the condition for a star to be circumpolar is $\delta > 90 - \varphi$, where δ is the declination and φ is the latitude of the observing site. (b) A star has declination $\delta = 25^o$. With the help of a suitable diagram, find its minimum and maximum zenith distance if the observer is located at 40^o N. Draw the diurnal trajectory of the star in equatorial coordinate system.

Q2. An astronomer observes a star in a galaxy has magnitude 12. If an emission line from the star is (rest wavelength = 656 nm) observed at 658 nm, what is the distance to the galaxy? What is absolute magnitude of the star? How many times the star is more luminous than the sun? Explain the significance of Hubble's Law. (Absolute mag. of sun = + 4.74, $H_o = 72$ km/s/Mpc)

Q 3 The intensity profile of an elliptical galaxy is given as:

$I(r) = I(0)\ 10^{(-3.33)b}$, where $b = (r / r_e)^{1/4}$, r_e is the effective radius and I(0) is the intensity at r = 0. Show that the total light emitted by the galaxy is $3.37 \times 10^{-3} I(0)\pi r_e^2$. Also prove that the surface brightness $\mu(r)$ of elliptical galaxy expressed in magnitude per square arc second at distance r from the centre can be written as $\mu(0) + 8.325 (r/r_e)^{1/4}$

Q 4. State and prove virial theorem for a N body system. Using the virial theorem, calculate the minimum mass needed for a uniform and non-rotating molecular cloud to initiate the collapse which give rises to the birth of a star. Assume that the mass and radius of the cloud are M and R respectively. The cloud has N number of particles at temperature T.

Q 5 Assume that dark matter in a galaxy has a density distribution which varies with distance r as :

$\rho(r) = \rho_o (r_o/r)$, where ρ_o and r_o are constants.

Sketch the density distribution $\rho(r)$ as a function of r. Calculate the mass enclosed M(r) within distance r from the center. Obtain the rotational velocity as implied by this mass distribution. Describe one key observation that suggest the presence of dark matter in the Milky Way galaxy.

Q6. Define tidal forces and derive its expression. Estimate the distance of a satellite from its planet so that it is tidally disrupted. Assume that densities of the planet and the satellite are ρ_p and ρ_m respectively. The radii of the planet and the satellite are R_p and R_m respectively. Explain the significance of this distance.

Useful constants:

$G = 6.67 \times 10^{-11}$ m^{-3} kg^{-1} s^{-2}

$k_B = 1.38 \times 10^{-23}$ J/K

$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}

$M_{sun} = 1.99 \times 10^{30}$ kg

$R_{sun} = 6.96 \times 10^{8}$ m

$L_{sun} = 3.86 \times 10^{26}$ W

1 A. U. = 1.5×10^{11} m