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. $= 1.5 \times 10^{11}\ m$

03.01.24(M)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4481 **G**

Unique Paper Code : 32227506

Name of the Paper : Astronomy & Astrophysics

Name of the Course : **B.Sc. (Hons.) Physics – DSE**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question No. **1** is compulsory.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any **five** of the following : (5×3)

(a) Balmer lines are not seen in the spectra of either O stars or K stars. Explain.

(b) What is the Sun's approximate RA on the following dates: June 7, Jan. 22 & Sept. 28.

(c) What is the approximate LST at noon on July 22?

(d) The star system 61 Cygni has a radial velocity of 64 km/sec, a proper motion of 5.28"/yr, and a distance of 3.498 pc. What is its space velocity?

(e) What is Olber's paradox? How is it resolved?

(f) For a spherical galaxy, determine the density profile $\rho(r)$ for which rotational velocity , $v_c(r)$ is independent of r. (r is the distance from the center of galaxy).

7. (a) Describe a method for obtaining a distance estimate for :

(i) a galaxy whose approximate distance is 20 Mpc and

(ii) a star at a distance of 10 kpc.

(b) Suppose a quasar shows absorption from a Lyman-alpha cloud at an observed wavelength $\lambda_0 = 183$ nm.

(i) Given that Lyman-alpha has a rest wavelength of about $\lambda = 122$ nm, what is the redshift z for this cloud.

(ii) For a Hubble constant $H_0 = 67$ km/s/Mpc, what is its distance, in Mpc? (10,5)

P.T.O.

5. (a) Using Maxwell equations, derive the induction equation having both the convective and diffusive term. Discuss the importance of both the terms.

(b) The radius of the sunspot is $l = 10^4$ km and magnetic diffusivity $\eta = 10^3\ m^3\ s^{-1}$. Calculate the magnetic Reynold number if the velocity of the conducting fluid is $10^3\ m\ s^{-1}$. Explain the significance of the result obtained. (10,5)

6. (a) Derive an expression of radial velocity of a star in the neighbourhood of a sun as function of galactic longitude (l), distance between the star and the sun, d, and Oort's constant A.

(b) Assume the Oort constants A and B are + 15 km/s/kpc and −10 km/s/kpc respectively. Calculate the rotational velocity of the sun if it is 8.5 kpc away from the galactic center. (10,5)

2. (a) (i) Define apparent magnitude (m) and absolute magnitude (M). Show that $m = M + 5 \log_{10} D + 25$, where D is the distance measured in Mpc.

(ii) The angular diameter of star A with apparent bolometric magnitude of 2 is 2.5 times greater than the angular diameter of star B with apparent bolometric magnitude of 7. What is the ratio of temperature of star A to that of star B.

(b) Draw HR (Hertzsprung-Russell) diagram for classification of stars by incorporating Luminosity, temperature, absolute magnitude and spectral type. (10,5)

3. (a) (i) Suppose an astronomer wants to observe the star on celestial meridian with declination $\delta = -60°$. Which observatory should an

astronomer choose : Lick Observatory at latitude = 37° N or Keck observatory at latitude = 20° N (Explain with suitable diagram).

(ii) What are the advantages of reflecting type telescope over refracting type?

(b) For a gas of neutral hydrogen atoms, at what temperature is the number of atoms in the first excited state only 1% of the number of atoms in the ground state? (10,5)

4. (a) Consider a star with mass M and radius R. Assume that the star's density varies as a function of radius r according to the equation :

$$\rho = \rho_c [1 - (r / R)]$$

where ρ_c is the density at the center of the star.

(i) Calculate ρ_c in terms of M and R.

(ii) Calculate the mass of the star interior to radius r, M(r), as function of total mass M and radius R.

(iii) Using hydrostatic equilibrium, obtain an expression for the pressure, P(r) at radius r in terms of G, M and R. (Assume that P(R) = 0, the pressure drops to zero at the outer boundary)

(b) A globular cluster contain 10^6 stars, Assume that they all have same mass (1 $M_\odot$) and same speed (10 km/s). Use the virial theorem to estimate the characteristic size of the cluster.

(10,5)

P.T.O.