B.Sc.(Honours) Examination, 2019

Semester - VI

Physics (Honours)

Paper: BPE-5

(Theoretical and Observational Aspects of Astronomy)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***any four*** questions.

1. a) What do you mean by a celestial sphere?
   b) Show that the latitude of a place is equal to the altitude of the pole star.
   c) Draw the celestial sphere for an observer at the equator.
   d) Show the position of ecliptic on this celestial sphere.
   e) Show that for such an observer there are six months day and six months night. 2+2+2+2+2

2. a) The zenith distance of a star is 28°37′N. Find its polar distance (given the latitude of the place = 23°40′).
   b) What do you mean by constellations?
   c) Consider a star with right ascension θ and declination δN both are <90°, show the position of the star on a celestial sphere for an observer at Santiniketan.
   d) Will the right ascension and declination of a star change during the diurnal motion of a star?
   e) Show that $1\text{Pc} \approx 30.87 \times 10^{12}\,\text{Kms}$ (take 1AU = 149,600,000 Kms). 2+1+1+2+4

3. a) What do you mean by circumpolar star?
   b) If Z_1 and Z_2 are the zenith distances of a circumpolar star at the upper and lower culmination and upper culmination respectively, show that the latitude of the place and the declination of the star are given by

$$\phi = 90^{o} - \frac{(Z_1 + Z_2)}{2}$$

$$\delta = 90^{o} - \frac{(Z_1 - Z_2)}{2}$$

   c) Find the limit of declination for stars which are circumpolar at a place of latitude 30°N. 2+4+4

4. a) What are Giant Molecular Clouds (GMCs)?
   b) What is Jeans criterion? Obtain an expression for the Jeans mass.
   c) How does the fragmentation of the collapsing GMCs occur? What stops the fragmentation process? 2+(1+3)+(2+2)

5. a) Establish the virial theorem for a contracting protostar/pre-main-sequence star and also show that half of the released gravitational energy will increase the internal energy of the constituents and half will be radiated out.
   b) Estimate the lifetime of the sun on the basis of this theory.
   c) What is free-fall in the case of contraction of a self-gravitating object?
   d) Calculate the free-fall time for the sun of average matter density $\sim 1.4 \times 10^{3}\,\text{kg/m}^3$. Calculate the same for a GMC of average matter density $\sim 10^{-21}\,\text{kg/m}^3$. (3+1)+2+1+3

6. a) What are polytropes?
   b) Establish the Lane-Emden equation.

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c) Solve the above equation, imposing the necessary boundary conditions, for the n = 1 polytrope. Describe the density structure associated with an n = 1polytrope. 1+6+(2+1)

7. a) Show explicitly that a photon created at the centre of a star may take several thousand years to escape from its surface.
   b) Establish the radiative transfer equation and obtain its general solution.
   c) From the basic stellar structure equations, draw a relationship between the mass and the luminosity of a star. 3+(3+2)+2

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