Instruction for Candidates
1. Attempt *four* questions in all.
2. All questions carry equal marks.

1) a) Explain meaning of apparent magnitude, absolute magnitude of a star and hence derive the expression for distance modulus? A main sequence star A, at a distance 10 pc is barely visible through a space-based telescope capable to record all wavelengths. Another star B having temperature one third of A and radius 100 times of A is also barely visible by the same telescope. What is the distance of star B?

b) Explain meaning of Extinction of stellar light. What are the prominent causes of magnitude extinction of a star radiation? How will the distance measure of a star get affected by an inter stellar medium of optical thickness τ. Due to thick fog in New Delhi in winters, Sun seen through fog appears as bright as the full moon in cloudless sky, find the optical thickness of the fog if the apparent magnitude of the Sun and the full moon are -26.81 and -12.5 respectively.

(8,10.75)

2) a) Derive an expression for the hydrostatic equilibrium and mass continuity equation for a star and explain their significance related to main sequence stars of HR diagram. Consider a self-gravitating spherical distribution of ideal gas with temperature T and density $\rho = \alpha r^{-2}$ in hydrostatic equilibrium. Deduce the value of α.

b) State and derive Virial theorem for N particle system. Show that the total energy of a self-gravitating sphere of a perfect monatomic gas is half of its gravitational potential energy. Explain meaning of Jean's instability? For a uniform, spherical, non-magnetic, and non-rotating self-gravitating gas cloud of mass M, density ρ, and, temperature T, derive the expression of Jeans Mass.

(7,11.75)

3) a) Write differences between horizon and equatorial coordinate system. Find the local equatorial coordinates Hour angle and Declination of a star at latitude 40° at the instant when the star zenith distance is $z = 30^o$ and azimuth $A = 50^o$. Draw the diurnal motion of the star.

b) Consider two celestial objects A and B on a celestial sphere. Object A having declination 50° and hour angle 10 hr while object B have declination 80° and hour angle 12-hour 30 minute. Draw an appropriate diagram to show their approximate

position on celestial sphere and find out the angular distance between A and B.

(10,8.75)

4) a) Define Solar Constant and calculate its present value. How the value of solar constant will change if the temperature of the Sun's photosphere become 10,000 K and distance between the Sun and Earth is 0.5 A.U.? Derive the induction equation for the plasma in the presence of magnetic field for an astrophysical system like Sun and explain its different terms.

b) Explain three types of spectra observed for different astronomical phenomenon. Which spectra(s) is observed for Sun when observations are taken from ground of planet Earth? Justify. Why Sun is not observed as a blackbody with a temperature same as that of its corona which is the outermost layer of Sun's atmosphere?

(9.75,9)

5) Explain the meaning of scale factor $a(t)$ as defined in cosmology. Starting from Newtonian cosmology derive Friedmann equations in terms of scale factor and explain the model(s) of the universe based on derived equation. Using the Friedmann equation, show that for a flat universe having single fluid as non-relativistic matter or dust, the scale factor evolves as $a(t) \propto t^{2/3}$.

(3.75,12,3)

6) a) What is the meaning of differential rotational of Milky way galaxy? Obtain the expression for the Oort's constants and discuss their significance with respect to the Milky way galaxy.

b) Draw rotation curve of Milky way Galaxy and explain how this curve give indirect evidence for dark matter. If a spiral galaxy rotates as a rigid body than draw its rotation curve and qualitatively compare the amount of dark matter exist in such galaxy based on rotation curve. Assume that the fraction of visible matter is similar to other galaxies.

(11,8.75)