

U.G. 5th Semester Examination-2024**PHYSICS****[HONOURS]****Discipline Specific Elective (DSE)****Course Code : PHY-H-DSE-T-02****(Astronomy and Astrophysics)****[New Syllabus]**

Full Marks : 60

Time : $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***GROUP-A**

1. Answer any ten questions: $2 \times 10 = 20$
- What does the *Cosmic Microwave Background (CMB)* radiation represent in the context of astrophysics?
 - Define luminosity and radiant flux of a star.
 - What is Chandrasekhar Limit?
 - What would be the radius of a black hole with a mass 10 times as great as that of the Sun?
 - Write down the characteristics of a white dwarf star.
 - Write down the Saha ionization equation and explain it.

[Turn Over]

- vii) What is Hubble classification scheme?
- viii) Explain *Doplar Shift* phenomenon.
- ix) Explain the stellar nucleosynthesis.
- x) What is Zeeman effect?
- xi) A source and listener are moving towards each other with a speed of 54 km/hr. If the true frequency of sound emitted by the source is 500 Hz, calculate the observed frequency when both source and listener are moving towards each other.
(Velocity of sound in air = 330 ms⁻¹)
- xii) Define *parsec*. Convert this unit to SI unit.
- xiii) What is Red shift theory?
- xiv) What are the characteristics of active galaxies?
- xv) State the virial theorem of a planet and explain its significance.

GROUP-B

2. Answer any **four** questions : 5×4=20
- i) How did the planets form the solar nebula? Explain the three stages of the evolution of planets. 2+3
 - ii) What causes Tidal bulge of the Earth? The Cosmic Microwave Background (CMB) has a temperature of 2.7 K. What is its peak wavelength? 2+3

- iii) What is the ratio of the energy needed to escape the Earth vs. that needed to reach LEO? What is the ratio of the associated speeds? 3+2
- iv) An astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, what should be the distance between the lenses? 5
- v) Derive tidal force of the Earth and the Moon system. 5
- vi) Explain how the red-shift of galaxies supports the Big Bang theory. 5

GROUP-C

3. Answer any **two** questions from the following: 10×2=20
- i) Explain what is meant by a black-body. The intensity of radiation emitted per unit wavelength interval by a black-body of temperature T is given as a function of wavelength by,
- $$B(\lambda) = \frac{2h\epsilon^2}{\lambda^5} \frac{1}{e^{(hc/\lambda KT)} - 1}$$
- obtain an approximation for this formula appropriate for wavelengths such that $hc/\lambda KT \ll 1$. In what region of the electromagnetic spectrum would you expect this approximation to apply to the radiant emission from stars? 2+4+4

- ii) Explain what is meant by the term 'hydrostatic equilibrium' in stellar structure and discuss its importance.

A star is completely supported by radiation pressure and transport of energy is by radiation only. Use the equation of state $p = aT^{4/3}$ and the radiative transport equation,

$$L = \frac{16\pi r^2 acT^3}{3kp} \frac{dT}{dr}$$

(where L is the luminosity, k the opacity, ρ the density, r the radius, c the speed of light and a the radiation constant). Show that in hydrostatic equilibrium the luminosity (L) is,

$$L = \frac{4\pi GM \epsilon}{k}, \text{ where } G \text{ is the gravitational constant and } M \text{ is the total mass of the star.}$$

2+3+5

- iii) Discuss indirect method to find the stellar radii. Explain the *Eclipsing binary stars*. The luminosity of a star is 40 times that of the sun and its temperature is twice as much. Determine the radius of the star.

4+3+3