

**P.G. Semester-IV Examination, 2023****PHYSICS**

Course ID : 42452

Course Code : PHYS-402C

Course Title : Relativity &amp; Astrophysics

Time : 2 Hours

Full Marks : 40

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***UNIT-I**1. Answer any **three** of the following questions:

2×3=6

- What do you mean by affine connection?
- How does the curved space time appear in the Einstein field equation?
- Write down the principle of general covariance.
- What do you mean by event horizon?
- What do you mean by cosmic microwave background radiation?

2. Answer any **two** of the following questions:

4×2=8

- Write a short note on Minkowski's Four Dimensional Space-time.
- Write down the Robertson Walker metric. Write down the expression for Christoffel symbols of 1st and 2nd kind. Find the value of  $\Gamma_{01}^1$  in the Robertson Walker metric. 1+1+2=4
- Find the gravitational red shift in a static background of a planet considering vertical motion of a photon from the surface of the planet.
- Calculate age of the Universe and radius of the Universe from Hubble's Law.

3. Answer any **one** of the following questions:

6×1=6

- What do you mean by geodesic? Derive geodesic equation of a free particle in curved space -time from the principle of least action. 1+5=6
- What is Bianchi identity? Find the Einstein tensor from the Bianchi identity. 1+5=6

## UNIT-II

4. Answer any **three** of the following questions:

2×3=6

- a) State the Virial theorem.
- b) What do you mean by brown dwarf?
- c) Give an intuitive idea of gravitational equilibrium in a star.
- d) What do you mean by the main sequence stars?
- e) How low mass and high mass star formation is different?

5. Answer any **two** of the following questions: 4×2=8

- a) Write a short note on protostar.
- b) What do you mean by Chandrasekhar Mass. Derive the expression for Chandrasekhar mass?  
2+2=4
- c) What do you mean by dark matter and dark energy? Compare them. Is fusion reaction still going on inside the core of the sun? Explain with experimental evidence. 2+2=4
- d) What is missing Neutrino problem and how it has been solved?

6. Answer any **one** of the following questions: 6×1=6

- a) Discuss in details how the energy is produced in Sun. How does the element beyond iron formed? Give an example of s and r processes.  
3+1+2=6
- b) What do you mean by gravitational lensing? How do you estimate the mass of a galaxy from gravitational lensing? Discuss about the existence of dark matter from gravitational lensing.  
1+3+2=6