

Ex/SC/MATH/PG/DSE/TH/04/A28/2025

MASTER OF SCIENCE EXAMINATION, 2025

(2nd Year, 1st Semester)

MATHEMATICS

PAPER : DSE-04/A28

(Einstein's General Theory of Relativity)

Time : Two Hours

Full Marks : 40

Symbols/Notations have their usual meaning

Answer any **five** questions :

8×5=40

1. Define Geodesic. Derive the geodesic equation for the path of a particle in curved spacetime. (2+6)=8

2. (a) What do you mean by Isotropic co-ordinate system?

- (b) Rewrite the following line element

$$ds^2 = dt^2 - \frac{dr^2}{1 - \frac{m}{r^2}} - r^2(d\theta^2 + \sin^2\theta d\phi^2)$$

in isotropic co-ordinate.

(2+6)=8

3. (a) Define full domain of dependence with example.

- (b) Suppose the spacetime metric outside a star is given by

$$ds^2 = \left(1 - \frac{2M}{r}\right) [dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2)]$$

Find the angle of deflection of light by this spherical star. (3+5)=8

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[Turn Over]

(2)

4. Find the weak field approximation of Einstein equations. (8)

5. (a) Find interior solution when pressure (p) and density (ρ) are related as $p = -\rho$.

- (b) Find Newtonian limit of the TOV equation.

(5+3)=8

6. Describe the stable circular orbits in the Schwarzschild space time. (8)

7. (a) Define achronal set.

- (b) Suppose $\partial I^+(S)$ be an achronal boundary of the achronal set S . If $p \in \partial I^+(S)$, then show that $I^+(p) \subset I^+(S)$.

Using this result, show that the achronal boundary $\partial I^+(S)$ of the achronal set S is achronal. (2+6)=8

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