

# **ED-615**

M.A./M.Sc. 3rd Semester Examination, March-April 2021

## **MATHEMATICS**

Optional - B

Paper - III

General Relativity and Cosmology

Time: Three Hours] [Maximum Marks: 80]

**Note**: Answer any **two** parts from each question. All questions carry equal marks.

#### Unit-I

- 1. (a) Define contravariant and covariant vectors giving examples of gradient and tangent vectors in *n*-dimensional space and laws of transformation.
  - (b) State Quotient law of tensor. Let  $C_{jk}^i$  be a 3-index physical quantity, when it is multiplied to an arbitrary vector  $a_i$ , the multiplication  $C_{jk}^i a_i$  is a 2-index covariant tensor. Prove that  $C_{jk}^i$  is a tensor.

**DRG\_130\_**(3)

(Turn Over)

(2)

(c) Prove that

(i) 
$$a^i_{ji} = \frac{1}{\sqrt{-g}} \left\{ \left( \sqrt{-g}, a^i \right) \right\}, i$$

(ii) 
$$F_{ji}^{ij} = \frac{1}{\sqrt{-g}} \left\{ \left( \sqrt{-g} \right), F^{ij} \right\}, i$$

## Unit-II

- 2. (a) Define Riemann covariant tensor and prove its required expression for  $R_{hijk}$ .
  - (b) Derive Newtonian approximation of Relativistic equations of motion of a free particle in case of weak field.
  - (c) State and prove the necessary and sufficient condition for flat space time.

#### **Unit-III**

- **3.** (a) Obtain Einstein's law of gravitation of the material world which deduce some of its consequences.
  - (b) Show that Geodesic equations are reducible to Newtonian equation of motion in case of weak static field.
  - (c) Find expression for energy momentum tensor of an electromagnetic fluid.

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(Continued)

(3)

## **Unit-IV**

- **4.** (a) Obtain differential equation for equation of motion of a planet in Schwarzschild's metric.
  - (b) Discuss advance in perihelion of a planetary orbit for mercury.
  - (c) Discuss gravitational red shift from the point of view of Schwarzschild's metric.

#### Unit-V

- **5.** (a) Obtain Maxwell's field equations in tensor form.
  - (b) Obtain Schwarzschild's exterior solution of an isolated gravitational body.
  - (c) Obtain Reissner-Nordstrom solution for gravitational field.

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