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^i_{jk} be a 3-index physical quantity, when it is multiplied to an arbitrary vector a_i, the multiplication $C^i_{jk}\, a_i$ is a 2-index covariant tensor. Prove that C^i_{jk} is a tensor.

(*c*) Prove that

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

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

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.

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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