ED-2812

M.A./M.Sc. (Final) Examination, 2021

MATHEMATICS

Paper - V (i)

General Relativity and Cosmology

Time : Three Hours] [*Maximum Marks* : 100

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

Unit-I

1. (*a*) Prove that a skew symmetric tensor $A^{\mu\nu}$ in n dimension has $\dfrac{n(n-1)}{2}$ independent components.

   (*b*) Transform $ds^2 = dx^2 + dy^2 + dz^2$ in polar and cylindrical co-ordinates.

   (*c*) Define covariant derivative of a contravariant vector and show that it is a tensor.

DRG_27_(3) *(Turn Over)*

(2)

Unit-II

2. (*a*) Prove that vanishing of Riemann-Christoffel tensor is a necessary and sufficient condition for the flat space time.

   (*b*) Show that geodesic equations are reducible to Newtonian equation of motion in case of weak static field.

   (*c*) State Einstein principle of equivalence. What are the observable consequences of general theory of relativity ?

Unit-III

3. (*a*) Derive Schwarzschild interior solution of a spherically symmetric distribution of matter with constant density.

   (*b*) On the basis of general theory of relativity discuss the bending of light ray passing closed to the heavy gravitational mass.

   (*c*) Derive the formula for energy momentum tensor for a perfect fluid in the form

$$T_v^\mu = (\rho + p)^{v_\mu v^v - g_v^\mu \rho}$$

Unit-IV

4. (*a*) Describe de Sitter's model of the universe and discuss its physical property.

DRG_27_(3)   *(Continued)*

(3)

(*b*) Obtain the line elements for Einstein universe and discuss its property.

(*c*) Obtain the line elements of Robertson Walker. Show that model reveal that universe is expanding.

Unit-V

5. (*a*) State and explain motion of a test particle in de Sitter universe.

(*b*) Discuss Eddington-Lemaitre cosmological model with cosmological constant Λ.

(*c*) Write short notes on the following :

(*i*) Cosmological model

(*ii*) Robertson non-static cosmological model

(*iii*) Einstein universe

(*iv*) Matter dominated era of the universe

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