(PART-B : Descriptive)

Time : 2 hrs. 40 min. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. Write briefly the derivation of FRW metric. 10

2. a. Discuss the principle of General Relativity. 5+5=10
   b. Write briefly about the significance of Geodesic Coordinate System?

3. a. What is Bianchi Identity 2+8=10
   b. Find the Bianchi Identity.

4. Mention the four considerations for formulating Einstein's Field Equation and explain them in details. 4+6=10

5. State and Prove Geodesic Equation. 1+9=10

6. Explain Hublle's law. Also briefly write, what is the role of Hublle's law. 6+4=10

7. What is the condition for parallel displacement? Find the Curvature Tensor. 1+9=10

8. What do you mean by Cosmology? If there exists any principle of Cosmology, then explain it briefly. 3+3+4=10

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M.Sc. MATHEMATICS
FOURTH SEMESTER
GENERAL THEORY OF RELATIVITY
MSM-404

(Use separate answer scripts for Objective & Descriptive)

Duration : 3 hrs. **Full Marks : 70**

(PART-A : Objective)

Time : 20 min. **Marks : 20**

Choose the correct answer from the following: ***1x20=20***

1. A Geodesic is:
   a. Space time
   b. Straight line
   c. Straight line in Space
   d. Curve

2. Equation of Geodesic in Flat Space time:
   a. $\frac{dv^{\mu}}{dx} = 0$
   b. $\frac{dv^{\mu}}{ds} = 0$
   c. $\frac{dv}{ds} = 0$
   d. $\frac{dv^{\mu}}{ds^{2}} = 0$

3. Which is correct of the following?
   a. $A_{\mu;\alpha} = A_{\mu,\alpha} - \Gamma^{\beta}{}_{\mu\alpha} A_{\beta}$
   b. $A_{\mu;\alpha} = A_{\mu,\alpha} + \Gamma^{\beta}{}_{\mu\alpha} A_{\beta}$
   c. $A_{\mu;\alpha} = A_{\mu,\alpha} - \Gamma^{\beta}{}_{\mu\alpha} A^{\beta}$
   d. $A_{\mu;\alpha} = A_{\mu;\alpha} - \Gamma^{\beta}{}_{\mu\alpha} A_{\beta}$

4. $R_{\alpha\beta}$ is called:
   a. Curvature tensor
   b. Contravariant tensor
   c. Ricci Tensor
   d. None of the above

5. General Theory of Relativity included:
   a. One Principle
   b. Three principle
   c. No principle
   d. Two principle

6. Bianchi Identity is:
   a. $\left(R^{\alpha}{}_{\sigma} - \frac{1}{2} g^{\alpha}{}_{\sigma} R\right)_{;\alpha} = 0$
   b. $\left(R^{\alpha}{}_{\sigma} - \frac{1}{2} g^{\alpha}{}_{\sigma} R\right)_{;\alpha}$
   c. $\left(R^{\alpha}{}_{\sigma} - \frac{1}{2} g^{\alpha}{}_{\sigma} R\right) = 0$
   d. $\left(R^{\alpha}{}_{\sigma} + \frac{1}{2} g^{\alpha}{}_{\sigma} R\right)_{;\alpha} = 0$

7. The Poisson's law is:
   a. $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} = \pi G\rho$
   b. $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} = 4\pi G\rho$
   c. $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} = 4\pi\rho$
   d. $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} = 4\pi G$

8. The Curvature law in flat space time is:

a. $\frac{\partial T^{\mu}}{\partial x^{\nu}} = 0$

b. $\frac{\partial T^{\mu\nu}}{\partial x^{\mu}} = 0$

c. $\frac{\partial T^{\mu\nu}}{\partial x^{\nu}} = 0$

d. $\frac{\partial T^{\mu\nu}}{\partial x^{\nu}}$

9. According to Newton's law of Gravitation:

a. $m_i a = G\frac{M_g m_g}{R^2}$

b. $m_i a = \frac{M_g m_g}{R^2}$

c. $m_i a = G\frac{M_g m_g}{R}$

d. $m_i = G\frac{M_g m_g}{R^2}$

10. Principle of Equivalence gives:

a. Inertial mass

b. Gravitational mass

c. Both

d. Inertial mass=Gravitational mass

11. In Static condition:

a. $\frac{dx^1}{d\tau} = \frac{dx^2}{d\tau} = \frac{dx^3}{d\tau} = 0, \frac{dx^4}{d\tau} = 0$

b. $\frac{dx^1}{d\tau} = \frac{dx^2}{d\tau} = \frac{dx^3}{d\tau} = 0, \frac{dx^4}{d\tau} = ct$

c. $\frac{dx^1}{d\tau} = \frac{dx^2}{d\tau} = \frac{dx^3}{d\tau} = \frac{dx^4}{d\tau} = c$

d. $\frac{dx^1}{d\tau} = \frac{dx^2}{d\tau} = \frac{dx^3}{d\tau} = 0, \frac{dx^4}{d\tau} = c$

12. K.Schwarzschild derive the solution in:

a. 1961 b. 1916 c. 1691 d. 1619

13. When we consider large distance in spherically symmetric metric, I,e at $r \to \alpha$

a. Space time flat

b. Space time curve

c. Space curve

d. None of the above

14. Newtonian Gravitational potential is given by:

a. $\psi = -\frac{GM}{r}$

b. $\psi = -\frac{G}{r^2}$

c. $\psi = -\frac{GM}{r^2}$

d. $\psi = \frac{GM}{r^2}$

15. Cosmological Principle gives:

a. At epoch t, the Universe is homogenous and Isotropic.

b. At epoch t, the Universe is homogenous.

c. At epoch t, the Universe is non-homogenous and Isotropic.

d. At epoch t, the Universe is homogenous andnon- Isotropic.

16. Cosmology is the study of:

a. Universe

b. Dynamical evolution of Universe

c. Expansion of Universe

d. Contraction of Universe

17. $\frac{\dot{R}(t)}{R(t)}$ is known as:

a. Tensor

b. QUOTIENT law

c. Contraction

d. Hublle's law

18. Redshift is given by:

a. $\frac{\partial\lambda}{\lambda}$

b. $\frac{\partial\lambda}{\lambda}$

c. $\frac{\partial\lambda}{\lambda_0}$

d. $\frac{d\lambda}{\lambda_0}$

19. In FRW metric k has:

a. One value

b. Two value

c. Three value

d. 4 value

20. From FRW metric we get Closed Universe for:

a. $k > 1$

b. $k = 1$

c. $k < 1$

d. $k = -1$

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