REV-01
MSM/09/14

2024/05

SET A

M.SC. MATHEMATICS
FOURTH SEMESTER
GENERAL THEORY OF RELATIVITY
MSM – 403A

[USE OMR FOR OBJECTIVE PART]

Duration: 1:30 hrs. **Full Marks: 35**

Objective

Time: 15 mins. **Marks: 10**

Choose the correct answer from the following: ***1×10=10***

1. Which of the following option is correct
   a. $R^{\mu}_{\alpha\beta\gamma} = R^{\mu}_{\alpha\gamma\beta}$
   b. $R^{\mu}_{\alpha\beta\gamma} = -R^{\mu}_{\alpha\gamma\beta}$
   c. $R^{\alpha}_{\alpha\beta\gamma} = -R^{\alpha}_{\alpha\gamma\beta}$
   d. $R^{\mu}_{\alpha\beta\gamma} = -R^{\mu}_{\gamma\alpha\beta}$

2. Which of the following option is correct
   a. $DA_{\mu} = g_{\mu\nu}(DA^{\mu})$
   b. $DA_{\mu} = g_{\mu\nu}(DA^{\nu})$
   c. $DA_{\nu} = g_{\mu\nu}(DA^{\nu})$
   d. none of the above

3. Einstein's Field Equation Describes
   a. Shape of Universe
   b. principle of equivalence
   c. How mass and momentum create curvature in spacetime
   d. None of the above

4. The static line element is
   a. $ds^2 = -e^{\lambda(r)}dr^2 - r^2 d\theta^2 - r^2 \sin\theta d\phi^2 + e^{\nu}c^2dt^2$
   b. $ds^2 = e^{\lambda(r)}dr^2 - r^2 d\theta^2 - r^2 \sin\theta d\phi^2 + e^{\nu}c^2dt^2$
   c. $ds^2 = -e^{\lambda(r)}dr^2 - r^2 d\theta^2 - r^2 \sin\theta d\phi^2 - e^{\nu}c^2dt^2$
   d. $ds^2 = +e^{\lambda(r)}dr^2 + r^2 d\theta^2 + r^2 \sin\theta d\phi^2 + e^{\nu}c^2dt^2$

5. The first approximation solution of $\frac{d^2u}{d\phi^2} + u = \frac{m}{h^2} + 3mu^2$ is
   a. $u = \frac{m}{h^2}\left[1 + e\cos(\phi + w)\right]$
   b. $u = \frac{m}{h^2}\left[1 - e\cos(\phi - w)\right]$
   c. $u = \frac{m}{h}\left[1 + e\cos(\phi - w)\right]$
   d. $u = \frac{m}{h^2}\left[1 + e\cos(\phi - w)\right]$

6. Potential difference between the surface of the Sun and the Earth is

a. $-\frac{GM}{R}$ b. $-\frac{GM}{R^2}$

c. $\frac{GM}{R}$ d. $\frac{GM}{R^2}$

7. Poisson's Law of Gravitation is

a. $\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}=4\pi G\rho$ 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. $\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=4\pi G\rho$ d. $\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=-4\pi G\rho$

8. Principle of Equivalence gives

a. Accelerated mass b. Gravitational mass

c. Accelerated field=Gravitational field d. Inertial mass

9. The covariant derivative of the contravariant vector A^μ is given by

a. $A^\mu{}_{;\beta}=\frac{\partial A^\mu}{\partial x^\beta}+\Gamma^\nu{}_{\alpha\beta}A^\alpha$ b. $A^\mu{}_{;\beta}=\frac{\partial A^\mu}{\partial x^\beta}+\Gamma^\mu{}_{\alpha\beta}A^\alpha$

c. $A^\mu{}_{;\alpha}=\frac{\partial A^\mu}{\partial x^\beta}+\Gamma^\mu{}_{\alpha\beta}A^\alpha$ d. $A^\mu{}_{;\alpha}=\frac{\partial A^\mu}{\partial x^\alpha}+\Gamma^\mu{}_{\alpha\beta}A^\alpha$

10. If Δt_A is the time measured by static clock A for the journey B and Δt_B the corresponding time measured by moving clock B, then which of the following is correct.

a. $\Delta t_A > \Delta t_B$ b. $\Delta t_B > \Delta t_A$

c. $\Delta t_B \geq \Delta t_A$ d. $\Delta t_A \geq \Delta t_B$

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Descriptive

Time : 1 hr. 15 mins. **Marks : 25**

[Answer question no.1 & any two (2) from the rest]

1. What are the four consideration of Einstein's Field Equation? Prove that **4+1=5**

$$\left(R^{\mu\nu} - \frac{1}{2} g^{\mu\nu} R + \Lambda g^{\mu\nu} \right)_{;\nu} = 0$$

2. What is the equation of Geodesic in Flat space time? Prove that **1+9=10**

$$\frac{d^2 x^\mu}{ds^2} + \Gamma^\mu{}_{\alpha\beta} \frac{dx^\alpha}{ds} \frac{dx^\beta}{ds} = 0$$

3. **a.** Write Principle of General Relativity **5+5=10**

   b. Prove that
   (i) inertial mass =gravitational mass
   (ii) $a = g$

4. What is difference between flat space time and curved space time? Prove that **10**

$$DA^\mu = \left(\frac{\partial A^\mu}{\partial x^\beta} + \Gamma^\mu{}_{\alpha\beta} A^\alpha \right) dx^\beta$$

5. What are the three experimental tests? Find the advance for Mercury ∂w. Write the difference of actual advance and observed advanced of Mercury. **3+1+6 =10**

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