

**UG (Regular) (Sem.-I) Examination, 2023**

**( Session : 2023-27 )**

**( MIC-1 - MINOR COURSES )**

**PHYSICS**

**Paper Code : 520501**

**( Introduction to Mathematical Physics  
& Classical Mechanics )**

**Time : Three Hours]**

**[Maximum Marks : 70**

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**Note :** Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks. Answer from **all** the Parts as directed.

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**Part-A**

**(Objective Type Questions)**

**Note :** Select the correct answer from the option given below and each question carrying two marks. [10×2=20]

1. (i) Consider the differential equation  $(y')^2 + xy^3 = 0$ . Its order and degree are, respectively :
- (a) 1, 2
  - (b) 1, 3
  - (c) 2, 1
  - (d) None of these
- (ii) The derivative of even function is :
- (a) Even function
  - (b) Odd function
  - (c) Zero
  - (d) None of these
- (iii) Electric current is :
- (a) Scalar
  - (b) Vector
  - (c) Scalar and Vector
  - (d) None of these
- (iv) If  $y = A \sin x + B \cos x$  then  $\frac{d^2 y}{dx^2}$  is equal to :

- (a)  $A \cos x + B \sin x$
- (b)  $y$
- (c)  $-y$
- ~~(d)  $A \cos x - B \sin x$~~
- (v) The equation  $\vec{A} + \vec{B} = \vec{A} - \vec{B}$  is true when vector  $\vec{B}$  is a :
- (a) Unit vector
- (b) Null vector
- ~~(c) Polar vector~~
- (d) None of these
- (vi) What is the value of  $(\vec{\nabla} \times \vec{r})$  ?
- ~~(a) 0~~
- (b) 1
- (c) 2
- (d) 3
- (vii) The basic laws of Physics are identical in all :
- ~~(a) Non-inertial frame of reference~~

- (b) Inertial frame of reference
- ~~(c)~~ Both (a) and (b)
- (d) None of these
- (viii) A body in motion on earth experiences :
- ~~(a)~~ Only Centrifugal force
- (b) Only Coriolis force
- (c) Both Centrifugal and Coriolis force
- (d) None of these
- (ix) At which place on the earth, the plane of oscillation of a Foucault pendulum does not rotate?
- (a) South pole
- (b) North pole
- ~~(c)~~ Equator
- (d) None of these
- (x) The relativistic formula for the variation of mass with velocity is :

(a) 
$$m = \frac{m_0}{\left(1 - \frac{v^2}{c^2}\right)}$$

(b)  $m = \frac{m_0}{\sqrt{1 + \frac{v^2}{c^2}}}$

(c)  $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

(d) None of these

### Part-B

#### (Short Answer Type Questions)

**Note:** Four questions are to be answered out of six questions.  
Each carrying five marks. [4×5=20]

2. What do you mean by the differential equation? Explain with example.
3. If  $\vec{A} = 3\hat{i} + 4\hat{j} - 3\hat{k}$  and  $\vec{B} = \hat{i} - 2\hat{j} + 3\hat{k}$ . Calculate  $\vec{A} \cdot \vec{B}$  and  $\vec{A} \times \vec{B}$ .
4. State the postulates of the special theory of relativity and explain.
5. If  $\vec{r}$  is the position vector of a point, then evaluate :  
(a)  $\text{div } \vec{r}$

(b)  $\text{grad} \left( \frac{1}{r} \right)$

6. Distinguish between inertial and non-inertial frames of reference with examples.

7. Justify  $f(x, y) = \sin^{-1} \left( \frac{\sqrt{x} + \sqrt{y}}{x^2 + y^2} \right)$  is homogeneous or inhomogeneous.

### Part-C

#### (Long Answer Type Questions)

**Note:** Three questions are to be answered out of five questions. Each carrying ten marks.  $[3 \times 10 = 30]$

8. Write down the general solution for first order linear ordinary differential equation. If  $U = e^{xyz}$ , find the value of  $\frac{\partial^3 U}{\partial x \cdot \partial y \cdot \partial z}$  :  $[6+4]$

9. (i) Prove that :  $|\vec{A} \times \vec{B}|^2 + |\vec{A} \cdot \vec{B}|^2 = A^2 B^2$ .  $[4]$

(ii) A particle moves along the curve

$$\bar{R} = (t^2 - 4t)\hat{i} + (t^2 + 4t)\hat{j} + (8t^2 - 3t^3)\hat{k}$$

where ' $t$ ' denotes time. Find the magnitude of velocity and acceleration at  $t = 4$  seconds. [6]

10. (i) If  $\phi(x, y, z) = 3xy^2 - y^2z^3$ , find the value of  $\text{grad } \phi$  at the point  $(1, -3, -2)$ . [5]

(ii) What is the condition of maxima and minima? Discuss. [5]

11. (i) Define Centrifugal force and Coriolis force. Obtain the expression for them in the rotating frame. [10]

12. Write short notes on the following :

(i) Length contraction [5]

(ii) Time dilation [5]

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**THE END**