

**Sundarban Mahavidyalaya**  
Part-I (1+1+1 system)  
Intermediate Examination 2020  
Subject: Physics; Paper: I  
Full Marks: 50; Time: 2 hrs

Answer Question No. 1 and two questions each from Unit-I and Unit-II as prescribed therein

**1 Answer any five questions of the following:**

2X5

- 1.1 Let  $A$  be a square finite dimensional matrix with real entries such that  $AA^T = I$ , where  $A^T$  denotes the transpose of  $A$ . Show that  $A^T A = I$
- 1.2 Show that  $\vec{\nabla}\phi$  is a vector perpendicular to the surface  $\phi(x, y, z) = \text{constant}$ .
- 1.3 Show that  $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$  for any vector  $\vec{A}$ .
- 1.4 Examine the convergence of the series

$$\sum_{n=1}^{\infty} \frac{x^n}{n!}$$

- 1.5 Show that when a conservative force acts on a particle of mass  $m$ , the sum of its potential and kinetic energies is constant.
- 1.6 What are combination tones?
- 1.7 Find whether  $d\phi$  is an exact differential where  $d\phi = (x^2 - y)dx + xdy$ .

Unit-I

Answer *anytwo* questions from this Unit-I

2X10

**2 Question No. 2 of Unit-I**

- 2.1 State Green's theorem in a plane.
- 2.2 Show that the area bounded by a simple closed curve  $C$  in a plane is given by

$$\frac{1}{2} \times \oint_C (x dy - y dx)$$

- 2.3 Solve the equation  $(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 6y = 0$  around the point  $x = 0$ .

2 + 3 + 5

**3 Question No. 3 of Unit-I**

- 3.1 Prove that the series  $\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \dots$  is convergent and deduce its sum.

3

- 3.2 Find the eigenvalues and eigenvectors of the matrix

$$\begin{pmatrix} 1 & -2 \\ -2 & -2 \end{pmatrix}$$

3.3 Evaluate the double integral  $\iint_R (1 + \sqrt{x^2 + y^2}) dx dy$ . where  $R$  is the region bounded by the circle  $x^2 + y^2 = 1$

4 + 3

4 Given the matrix:

$$A = \begin{pmatrix} 1 & 0 & 5i \\ -2i & 2 & 0 \\ 1 & 1+i & 0 \end{pmatrix}$$

4.1 Test whether the matrix is orthogonal, hermitian, or unitary?

4.2 Find the inverse of the matrix.

4.3 Prove that the eigenvalue of a Hermitian matrix are all real.

4.4 The eigenvectors belonging to different eigenvalues are orthogonal to each other.

2 + 4 + 2 + 2

Unit-II

Answer *anytwo* questions from this Unit-II

2X10

5 Question no. 5 of Unit-II

5.1 Calculate the resultant of two SHMs of the same frequency acting along the same line but differing in phase .What is the amplitude when the phase difference is  $\frac{\pi}{2}$

5.2 Derive the differential equation of motion of a simple harmonic oscillator and its various solution.

5.3 What is free vibration ?

4 + 4 + 2

6 Question no. 6 of Unit-II

6.1 What are breakdown voltage?

6.2 Name and explain the different mechanisms of junction breakdown.

6.3 Distinguish between Zener breakdown and avalanche breakdown of a p-n diode.

2 + (1 + 2 + 2) + 3

7 Question no. 7 of Unit-II

7.1 Write down an expression of current for p-n diode.

7.2 What are the dynamic resistance? Find an expression for it.

7.3 Draw I-V characteristics for p-n junction.

7.4 What are the depletion region form in a p-n junction?

2 + (1 + 3) + 2 + 2