



‘समानो मन्त्रः समितिः समानी’

## UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 2nd Semester Examination, 2022

### GE1-P2-PHYSICS

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.  
All symbols are of usual significance.*

**The question paper contains GE2A and GE2B. Candidates are required to answer any *one* section from the *two* sections and they should mention it clearly on the Answer Book.**

#### GE2A

#### ELECTRICITY AND MAGNETISM

#### GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
  - (a) Find the value of  $x$  for which  $\vec{A} = \hat{i} + x\hat{j} + \hat{k}$  and  $\vec{B} = 2\hat{i} - 2\hat{j} - 2\hat{k}$  are perpendicular. 1
  - (b) Write the differential form of Gauss's law of electrostatic. 1
  - (c) Define the unit of capacitance. 1
  - (d) Why the equipotential surfaces do not intersect each other? 1
  - (e) Define electric flux. 1
  - (f) What do you mean by intensity of magnetism? 1
  - (g) Write down the equation of continuity of current. 1
  - (h) Write the Maxwell equation which indicates the absence of magnetic monopole. 1

#### GROUP-B

**Answer any *three* questions from the following**

**5×3 = 15**

2. (a) Find the unit normal to the surface  $x^2y + 2xz = 4$  at the point  $(2, -2, 3)$ . 2
  - (b) If  $\vec{r}$  be the position vector then find the value of  $\text{grad}\left(\frac{1}{r}\right)$ . 3
3. (a) Find the capacitance of a parallel plate capacitor when a dielectric of breadth ' $t$ ' is placed between the plates of the capacitor. 4
  - (b) Write the integral form of Ampere's circuital law. 1

4. (a) Define electric dipole. Give unit of electric dipole moment. 1+1  
 (b) Find the electric potential at a point due to electric dipole. 3
5. (a) State and explain Lenz's law. Also show that it supports the conservation of energy. 4  
 (b) Write down the Maxwell equation, which can be derived from Faraday and Lenz law. 1
6. State and explain Biot-Savart law in magnetostatic and hence calculate the magnetic induction at a point due to a straight infinitely long current carrying wire. (Assume steady current flow) 2+3

**GROUP-C**

**Answer any two questions from the following**

10×2 = 20

7. (a) Find the value of  $\text{div}(r^n \vec{r})$ , where  $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ . Find the value of  $n$  for which  $(r^n \vec{r})$  is solenoidal. 4+2  
 (b) If  $\vec{v} = \vec{w} \times \vec{r}$ , show that  $\frac{1}{2} \text{curl} \vec{v} = \vec{w}$ , where  $\vec{w}$  is a constant vector and  $\vec{r}$  is the position vector. 4
8. (a) Find the electric field for a plane charged sheet using Gauss's theorem. 5  
 (b) Prove that, 3
- $$\nabla^2 \phi = -\frac{\rho}{\epsilon_0}$$
- where  $\phi$ ,  $\rho$  and  $\epsilon_0$  have their usual meaning.
- (c) Find the electric field at point (2, 1, 2) where electric potential is given by  $\phi = -x^2y + 2z$ . 2
9. (a) Distinguish between dia, para and ferromagnetic substances. 5  
 (b) A steady current  $I$  flows down a long cylindrical conductor of radius  $a$ . The current density at a distance  $r$  from the axis of the conductor is proportional to  $r$ . Calculate the magnetic field both inside and outside of the wire as a function of  $r$ . 5
- 10.(a) Show from Maxwell's equation that velocity of a plane electromagnetic wave in an isotropic dielectric medium is,  $v = c/\sqrt{k}$ , where  $k$  is dielectric constant of that medium. 5  
 (b) What is Poynting vector? Find its relationship with electric and magnetic field. 2+3

## GE2B

## WAVES AND OPTICS

## GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
- (a) What is the condition of occurrence of resonance in a forced harmonic oscillator?
- (b) Why sound waves cannot be polarized?
- (c) Light waves from the two sources of the same intensity ' $I$ ' interfere. The intensity of light of maxima is given by:
- (i)  $I$             (ii)  $I^2$             (iii)  $2I$             (iv)  $4I^2$
- (d) Why the central fringe formed due to the interference from Lloyd's mirror is black?
- (e) What do you mean by plane polarized light?
- (f) What is the effect on the diffraction pattern if the distance between the slits is made very large?
- (g) What do you mean by a wavefront?
- (h) What is a 'negative zone plate'?

## GROUP-B

Answer any *three* questions from the following

5×3 = 15

2. (a) Mention different possible modes of vibration in a stretched string fixed at its ends. 3
- (b) Write down the advantages and disadvantages of reverberation. 2
3. (a) Distinguish between 'plane of vibration' and 'plane of polarization' by doing a pictorial representation of plane polarized light. 2
- (b) Distinguish between the 'fringes of equal thickness' and the 'fringes of equal inclination' due to interference of light. 3
4. (a) What are 'nodes' and 'anti-nodes'? 2
- (b) Show that the principle of superposition is a consequence of the linearity of equation of motion. 3
5. (a) What is a diffraction grating? 1
- (b) Describe the nature of a fringe pattern when the white light is incident on a grating. 2
- (c) In Fraunhofer diffraction pattern formed by a single slit, suppose that the slit width is 0.03 cm and the wavelength of light is  $6 \times 10^{-5}$  cm. Find the diffraction angle for the first dark band. 2

6. (a) Describe how Michelson's interferometer can be used to determine the wavelength of a monochromatic light? 3  
 (b) Distinguish between the Lloyd's mirror fringes and the biprism fringes. 2

**GROUP-C**

**Answer any two questions from the following** 10×2 = 20

7. (a) A particle is subjected to two collinear simple harmonic motions of same frequency but having different amplitude. Find the expression for resultant motion. 5  
 (b) Show the graphical representation of beats. 2  
 (c) Calculate the amplitude and initial phase of the harmonic oscillations obtained by superposition of two collinear simple harmonic oscillations represented by following equations: 3

$$x_1 = 0.02 \sin\left(5\pi t + \frac{\pi}{2}\right)$$

$$x_2 = 0.03 \sin\left(5\pi t + \frac{\pi}{4}\right)$$

8. (a) What is the quality factor of a forced vibrating system? Derive the relation  $Q = \frac{1}{2b} \sqrt{\frac{k}{m}}$ , where the symbols have their usual meaning. 1+2  
 (b) Differentiate between amplitude and velocity resonance. 3  
 (c) Give an example of forced vibration and resonance. 2  
 (d) Define intensity and loudness of sound. 1+1

9. (a) Describe the formation of Newton's ring and find expressions for: 2+3+2  
 (i) diameter of bright and dark rings  
 (ii) Fringe-width.  
 (b) Calculate the fringe-width of interference pattern produced in Young's double slit experiment, with the slits  $10^{-3}$  m apart, on a screen 1 m away. Wavelength of light is 5893 Å. 3

10. (a) Explain the rectilinear propagation of light on the basis of the wave theory. 5  
 (b) What is a zone plate? Compare the zone plate with a convex lens. 1+2  
 (c) A zone plate has focal length 50 cm at a wavelength 6000 Å. What will be its focal length at  $\lambda = 5000$  Å? 2

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