



‘समानो मन्त्रः समितिः समानी’

UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 2nd Semester Examination, 2023

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
- Write down the Integral form of Faraday's law.
 - Find the value of 'a' if $(ax^2y + yz)\hat{i} + (xy^2 - xz^2)\hat{j} + (2xyz - 2x^2y^2)\hat{k}$ is solenoidal.
 - What is a conservative field?
 - Prove that $\nabla \times \vec{r} = 0$, where \vec{r} is the position vector.
 - What is Curie temperature of a ferromagnetic material?
 - Why equipotential surfaces do not intersect each other?
 - What is displacement current?
 - What do you mean by Magnetic vector potential?

GROUP-B

Answer any *three* questions from the following 5×3 = 15

- Evaluate $\oiint \vec{r} \cdot \hat{n} ds$ over the unit cube defined by $x=0, y=0, z=0$ and $x=1, y=1, z=1$. 3
 - Prove that the divergence of curl of a vector is zero. 2
- Find the relation between potential difference between two points and electric field. 2
 - Find the electric potential due to a uniformly charged solid sphere at a point inside the sphere. 3

4. (a) Define mutual inductance of two coils. 2
 (b) Find the equivalent inductance of two magnetically coupled coils when they are joined in series. 3
5. (a) Show that the energy is equally shared between electric and magnetic fields, when an electromagnetic wave is passing through free space. 2
 (b) Write down the Maxwell's Equations in a transparent dielectric medium and explain the different symbols used in the equations. 3
6. (a) Derive an expression for the magnetic field intensity at a point on the axis of a circular coil of wire carrying electric current. 3
 (b) Find the magnetic field strength at the centre of a short circular coil 15 cm in diameter, containing 10 turns and carrying a current of 10 ampere. 2

GROUP-C

Answer any two questions from the following

10×2 = 20

7. (a) Establish the relation $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$, where the symbols have their usual meaning. Hence, define and explain each term individually. 3+2
 (b) Calculate the capacitance of a parallel plate capacitor completely filled with dielectric material. Why the capacitance is more than a parallel plate capacitor without dielectric? 4+1
8. (a) Write down Maxwell's equation of electromagnetic theory for vacuum. 1
 (b) Show from Maxwell's equation that the velocity of a plane electromagnetic wave in vacuum is equal to c (speed of light). 4
 (c) What is Poynting vector? Find its relation with electric and magnetic field vectors. 2+3
9. (a) State Gauss' Law of Electrostatics and hence deduce its differential form. 1+2
 (b) Applying Gauss' Law, find the electric field for a uniformly charged hollow spherical shell at points outside it, inside the material and in the inner cavity. Hence, sketch the variation of \vec{E} with distance (r) of the point from the centre of the shell. 2+2+2+1
10. (a) Find $\nabla \cdot (r^n \vec{r})$, where \vec{r} is the position vector. 3
 (b) Show that $\text{curl} \cdot \text{grad} \phi = 0$, where ϕ is any scalar function. 3
 (c) Define magnetic permeability and susceptibility and show how these are related to each other. 1+1+2

GE2B

WAVES AND OPTICS

GROUP-A

1. Answer any *five* questions from the following: 1×5 = 5
- (a) What do you mean by reverberation time? 1
- (b) Distinguish between longitudinal and transverse waves. 1
- (c) What do you mean by a coherent source? 1
- (d) State the factors on which speed of a transverse wave in a string depends. 1
- (e) If the path difference between two waves be $\frac{3\lambda}{2}$. What will be their phase difference? 1
- (f) What do you mean by circularly polarized light? 1
- (g) What are beats? 1
- (h) What do you mean by sharpness of resonance? 1

GROUP-B

Answer any *three* questions from the following 5×3 = 15

2. (a) Differentiate between phase velocity and group velocity. Obtain the relation between them. 2+2
- (b) What are the factors on which intensity of a wave depends? 1
3. (a) What is meant by interference of light? What happens as a result of interference? 1+1
- (b) Which is the necessary condition to observe sustained interference pattern for light waves? 1
- (c) The interference pattern is produced by illuminating two identical thin slits by light of wavelength 5893 Å. The distance of separation of the two slits is 0.25 mm and the screen is placed at a distance of 1 m from the plane of the slits. If the light travels perpendicular to the plane of the slits, find the separation between adjacent bright bands. 2
4. (a) What are Lissajous figures? 1
- (b) Two simple harmonic motions at right angles and having same frequency are superposed on each other. Find out the expression for resultant motion. Discuss the cases when phase difference between them are (i) 0° (ii) 90° respectively. 4
5. Explain the formation of Newton's rings and deduce an expression for the diameters of the rings. 2+3
6. (a) Explain how a Michelson's Interferometer can be used to determine the difference in wavelengths. 3
- (b) Distinguish between Fresnel and Fraunhofer types of diffraction. 2

GROUP-C

Answer any two questions from the following

10×2 = 20

7. (a) What are standing waves? How are they formed? 2
 (b) Discuss analytically the formation of standing waves on a stretched string fixed on both the ends. 4
 (c) Find the eigen frequencies of the above vibration. 1
 (d) While emitting its fundamental, the frequency of a stretched string is 30 Hz. The length of the string is 60 cm and mass per unit length is 0.5 g/cm. Find the velocity of transverse wave and tension of the string. 3
8. (a) What is a plane diffraction grating? Define what you mean by grating element. 1+1
 (b) Determine the resolving power of a plane diffraction grating. 5
 (c) A diffraction grating has 5000 lines per centimeter. How many orders of spectra of light of wavelength 6000 Å can be obtained with it? What is the wavelength of the light whose third order spectrum coincides with the second order spectrum of light of wavelength 6000 Å? 3
9. (a) What are the conditions to be satisfied for an acoustically acceptable auditorium? 3
 (b) Give examples of vibrating systems which exhibit sharp and flat resonance responses. 3
 (c) Write down Sabine's formula. 1
 (d) A particle executes simple harmonic motion given by the equation 3

$$y = 12 \sin\left(\frac{2\pi t}{10} + \frac{\pi}{4}\right)$$
. Calculate
 (i) amplitude
 (ii) frequency and
 (iii) displacement at $t = 1.25$ s.
10. (a) Describe how plane polarized light can be produced using Nicol prism. 3
 (b) How do you determine whether a light beam is plane polarized? 2
 (c) What is a quarter waveplate? 1
 (d) What is the nature of emergent polarized light when circularly polarized light is passed through 1+1
 (i) a quarter waveplate
 (ii) a half waveplate.
 (e) Plane polarized light is incident normally as a piece of quartz cut parallel to the optic axis. Find the least thickness for which the emergent light is plane polarized light. The extraordinary and ordinary refractive indices are 1.5533 and 1.5442 respectively. The wavelength of the light is 5×10^{-5} cm. 2

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