'समानो मन्त्रः समितिः समानी'

UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 4th Semester Examination, 2022

GE2-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 GE-4A and GE-4B. Candidates are required to answer any *one* paper from the *two* papers and they should mention it clearly on the Answer Book.

GE-4A

ELECTRICITY AND MAGNETISM

GROUP-A

1. Answer any ***five*** questions from the following: 1×5 = 5

   (a) What is the unit of capacitance? 1

   (b) What is the unit of magnetic field intensity? 1

   (c) What is electric dipole? 1

   (d) What is polarization of a dielectric medium? 1

   (e) Give an example of diamagnetic material. 1

   (f) Define directional derivative. 1

   (g) What is the dimension of electric flux? 1

   (h) Define electric displacement vector. 1

GROUP-B

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

2. (a) Define dielectric constant of a medium. 1

   (b) Apply Gauss' theorem to find the intensity of the electrostatic field near a charged plane conductor. 4

3. (a) Define coefficient of self-inductance and coefficient of mutual inductance. What is the S.I. unit of them? 3+1

   (b) What is Lenz's law? 1

4. (a) What is a conductor? 1

   (b) State the different electrostatic properties of a conductor. 2

   (c) Find out the amount of energy stored within a capacitor. 2

5. (a) Obtain the equation of continuity of current. 2

   (b) Show that magnetic force does not do any work. 3

6. (a) State Biot-Savart law for magnetostatics. 2

   (b) Find magnetic field at a point due to straight conductor. 3

GROUP-C

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

7. (a) Find out the gradient of $r = \sqrt{x^2 + y^2 + z^2}$. 2

   (b) Find out the divergence of $\vec{A} = x^2\hat{x} + 3xz\hat{y} + 3x^2z\hat{z}$. 2

   (c) Obtain the curl of $\vec{B} = -y\hat{x} + 2x\hat{y}$. 2

   (d) Calculate the surface integral of $\vec{A} = 2xz\hat{x} + (x+2)\hat{y} + y(z^2-3)\hat{z}$ over the six sides of a box as in fig.(1). 4

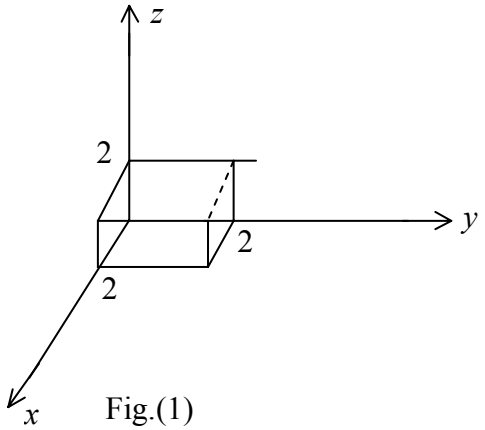

Fig.(1)

8. Write short notes on: 5×2 = 10

   (a) Poynting vector

   (b) Time, surface and volume integrals of vector fields.

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) Write the Maxwell's equation in a non-conducting medium. Derive the electromagnetic wave equation in this case. 2+4

(b) Obtain the energy density of the electromagnetic field. 4

GE-4B

WAVES AND OPTICS

GROUP-A

1. Answer any ***five*** questions from the following: 1×5 = 5

(a) State the factors on which speed of transverse wave on a string depend. 1

(b) What is the effect of damping on sharpness of resonance? 1

(c) What is "sabin"? 1

(d) What is a wave-front? 1

(e) What is a grating element? 1

(f) Define interference of light. 1

(g) What do you mean by "stationary" wave? 1

(h) Mention a medium where sound wave cannot travel. 1

GROUP-B

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

(a) (i) What do you mean by reverberation and time of reverberation for sound wave? 3+2

(ii) Write down Sabine's formula.

(b) (i) What do you mean by circularly polarized and elliptically polarized light? 2+3

(ii) Write down "Brewster's law" of polarization of light.

(c) How can we find the 'wavelength of monochromatic light' and 'small difference of wavelength of light' from a source by Michelson interferometer? 5

(d) (i) In which condition beats occur? What is beat frequency? (1+1)+3

(ii) Two linear simple harmonic motions of equal amplitude but of frequencies ω and 2ω are impressed simultaneously on a particle along the axes of X and Y respectively. If the initial phase difference between them is $\frac{\pi}{2}$, find the resultant path followed by the particle.

(e) (i) A sound is twice as intense as another. What is the difference in intensity levels of the two? 3+2

(ii) What are the basic differences between intensity and loudness of sound?

GROUP-C

3. Answer any ***two*** questions from the following: $10\times2 = 20$

(a) (i) What is forced oscillation? Establish the differential equation of it. What is the condition for resonance? (1+3+2)+4

(ii) Establish the relationship between group velocity and phase velocity.

(b) (i) What is the difference between Fresnel and Fraunhofer class of diffraction? 3+3+4

(ii) A slit of width 1 mm is illuminated by light of wavelength 589 nm. Find the angular spread of the central maximum of diffraction pattern observed.

(iii) Show that the grating with 5000 lines per cm cannot give a spectrum in the 4^{th} or higher order for light of wavelength 5890 Å.

(c) (i) Explain with diagram how the circularly polarized light can be analyzed. 5+2+3

(ii) Explain Huygen's principle for propagation of light.

(iii) A zone plate has focal length 50 cm at a wavelength 6000 Å. What will be its focal length at $\lambda = 5000$ Å?

(d) (i) Derive the expression for 'Fringe width' and 'shape of Fringes' for Newton's double slit experiment of Interference. 7+3

(ii) Write down the condition for observable pattern.

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