13DD 44 – III (28)

B.Sc. III Semester Degree Examination, November/December 2013
PHYSICS
Paper – 3.1 : Optical Instruments, Laser and Electrodynamics

Time: 3 Hours Max. Marks: 80

Instructions : *i) Section **I** is **compulsory**.*
*ii) Answer **any four** questions from Section **II** and **any four** from Section **III**.*

SECTION – I

1. Answer **any twelve** of the following : **(12×1=12)**

A) Choose the correct answer :

i) To reduce spherical aberration using a plano convex lens,
   a) the plane surface should face the incident light
   b) the curved surface should face the incident light
   c) either a) or b)
   d) none of the above

ii) Coherent sources are those, which have
   a) same amplitude b) same phase
   c) same frequency d) all of the above

iii) Gradient of a scalar field is a
   a) Scalar
   b) Vector
   c) Either a) or b) depending on the physical quantity
   d) None of the above

iv) According to equation of continuity,
   a) $\nabla \cdot \vec{J} + \frac{\partial D}{\partial t} = \vec{\nabla} \times \vec{H}$ b) $\nabla \cdot J = \frac{-\partial \vec{B}}{\partial t}$
   c) $\vec{\nabla} \cdot \vec{J} + \frac{d\rho}{dt} = 0$ d) None of the above

P.T.O.

B) Fill in the blanks :

i) Huygens eye-piece is used for _____ purposes.

ii) Curl of a position vector $\vec{r}$ is _____

iii) Laplace equation in electrostatics is expressed as _____

iv) Torque on a dipole is given by the formula _____

C) **True** or **false** :

i) The nodal points coincide with the focal points when the system is in air.

ii) According to Biot-Savart's law, flux density dB at a point is directly proportional to the square of the distance between the point and the element.

iii) Poynting vector $\vec{S}$ is defined as $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$.

D) Answer in **one** or **two** sentences :

i) What is Rayleigh criterion ?

ii) Mention one characteristic of laser.

iii) Give one example for vector field.

iv) State ampere's circuital law.

SECTION – II **(4×4=16)**

2. Obtain the expression for achromatism of two lenses separated by a distance 'd' by the method of calculus.

3. Write a note on semiconductor laser.

4. State and prove Gauss divergence theorem.

5. State and explain Coulomb's law in electrostatics and define Coulomb.

6. Write down Maxwell's equations.

7. Explain Hertz experiment to produce and detect electromagnetic waves.

SECTION – III

8. a) Derive the formula for equivalent focal length of two thin lenses placed co-axially in air and separated by a distance. Also derive the expression for α and β, which gives the position of principal points.

   b) Two thin convex lenses of focal lengths 20 cm and 5 cm are placed 10 cm apart. Calculate the positions of the principal points. **(9+4=13)**

9. a) Explain the recording and reconstruction process of a hologram based on the principle of division of wave front. Mention the conditions required for the same.

   b) Mention the applications of Lasers. **(9+4=13)**

10. a) Prove the vector identity,

    $\text{curl}\ (f \times g) = (\text{div}\ g)\, f - (\text{div}\ f)\, g + (g \cdot \nabla) f - (f \cdot \nabla) g$.

    b) Define cross product of two vectors. Give an example. **(9+4=13)**

11. a) Derive an expression for field at a point outside an infinitely charged cylinder.

    b) Calculate the electric potential at a point 9 m away from a charge of $1\mu F \cdot \varepsilon_0 = 8.854 \times 10^{-12} F/m$. **(9+4=13)**

12. a) Define magnetic flux. Obtain an expression for the magnetic field at a point due to a long straight conductor carrying current.

    b) A closely wound solenoid of 1000 turns has an axial length of 0.8 m and a radius of 1.5 cm. Find the flux density at the middle of the solenoid, when a current of 1.2 A flows through it. **(9+4=13)**

13. a) Derive an expression for equation of electromagnetic wave in isotropic non-conducting medium.

    b) A plane electromagnetic wave travelling along X-direction in an unbounded loss less dielectric medium of $\mu_r = 2$ and $\varepsilon_r = 5$ has a peak electric field strength of $10 Vm^{-1}$. Calculate the velocity of the wave.

    Given : $\varepsilon_0 = 8.854 \times 10^{-12} F/m$. **(9+4=13)**
