TDC (CBCS) Even Semester Exam., 2019

PHYSICS

(2nd Semester)

Course No. : PHYHCC-201T

(Electricity and Magnetism)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* of the following questions : 1×2=2

(a) There are two small conductors in air 30 cm apart. They carry 10 nC and 20 nC of charges respectively. Find the electric field at the midpoint between the two.

(b) A region is specified by the potential function given by

$$\phi = 4x^2 + 3y^3 - 9z^2$$

Calculate the electric field strength at any point (3, 4, 5) in this region.

(c) Show that the potential function

$$V = 2x^2 - 2y^2 + 4z$$

satisfies Laplace's equation.

2. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) State and prove Gauss' law in electrostatics. 4

(b) Using Gauss' law, prove that the electric field inside a hollow spherical charge distribution is zero. 4

(c) Deduce Poisson's and Laplace's equations from differential form of Gauss' law of electrostatics. 4

(d) Show that the electric potential on the equatorial line of electric dipole is zero. 4

UNIT—II

3. Answer any *two* of the following questions : 1×2=2

(a) On what factors does the capacitance of a parallel plate capacitor depend?

(b) A spherical conductor of radius 10 cm is charged to a potential of 1500 volt. Calculate its surface charge density.

(c) Distinguish between polar and non-polar dielectrics.

4. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Derive an expression for the capacitance of an isolated spherical conductor. 4

(b) Prove that the total electrostatic energy stored in a parallel plate capacitor is $\frac{1}{2}CV^2$. 4

(c) Derive the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$, where $\vec{D}$ is the electric displacement vector, $\vec{E}$ is the electric intensity and $\vec{P}$ is the dielectric polarization. Give the diagrammatic representation of the vectors $\vec{E}$, $\vec{D}$ and $\vec{P}$. 2+2=4

(d) Obtain Gauss' law as applied to dielectrics in integral and differential forms. 4

UNIT—III

5. Answer any *two* of the following questions : 1×2=2

(a) Given that $\vec{B} = \frac{\mu_0}{G_\pi} \frac{I}{r^2}(-y\hat{i} + x\hat{j})$, prove that $\vec{B}$ is a solenoidal field.

(b) State Biot-Savart law.

(c) What is the physical significance of magnetic vector potential?

6. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Using Biot-Savart law, find the magnetic field due to an infinitely long wire carrying current I at a distance r from it. 4

(b) Derive an expression for the force acting on a current carrying conductor placed inside a uniform magnetic field. 4

(c) Two straight long parallel conductors are carrying currents I_1 and I_2 in the same direction. Deduce an expression for the force per unit length between them. 4

(d) Derive an expression for the torque acting on a current loop placed in a uniform magnetic field. 4

UNIT—IV

7. Answer any *two* of the following questions : 1×2=2

(a) Define magnetic susceptibility and magnetic permeability.

(b) A coil has an inductance of 0·03 H. Calculate the e.m.f. induced when the current in the coil changes at the rate of 100 As^{-1}.

(c) Which of the Maxwell's equations indicates the absence of magnetic monopoles? Explain.

8. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Define $\vec{B}$ and $\vec{H}$ with reference to electromagnetism. Establish the relation

$$\vec{B} = \mu_0(\vec{H} + \vec{M})$$

where the symbols have their usual meanings. 2+2=4

(b) Prove that the hysteresis loss per cycle of magnetization is equal to the area of the B-H loop. 4

(c) State Faraday's laws of electromagnetic induction. Explain how Lenz's law does not violate the principle of conservation of energy. 1+3=4

(d) State and explain reciprocity theorem of electromagnetism. Distinguish between conduction current and displacement current. 2+2=4

UNIT—V

9. Answer any *two* of the following questions : 1×2=2

(a) An alternating voltage $E = 200\sin 314t$ is applied to a resistor of 10 ohm resistance. Calculate the r.m.s. values of voltage and current.

(b) What are the conditions for a moving coil galvanometer to be ballistic?

(c) State and explain superposition theorem.

10. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Explain the terms 'reactance' and 'impedance'. Explain the phase relation between voltage and current in an AC circuit containing resistance and inductance when voltage $V_0 e^{i\omega t}$ is applied. 2+2=4

(b) What do you mean by sharpness of resonance, bandwidth and quality factor in *L-C-R* series resonant circuit? What is resonant frequency? 1+1+1+1=4

(c) State Thevenin's theorem. Explain it and discuss the steps for solving a network utilizing Thevenin's theorem. 1+3=4

(d) Give the explanation of Norton's theorem. Do you agree that Norton's theorem is the converse of Thevenin's theorem? Explain. 4

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TDC (CBCS) Even Semester Exam., 2019

PHYSICS

(2nd Semester)

Course No. : PHYHCC-202T

(Waves and Optics)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* of the following questions : 1×2=2

(a) A wave of frequency 400 Hz is travelling with a velocity 800 m/sec. How far are two points situated whose displacement differs in phase by $\pi/4$?

(b) Show that $y = x^2 + c^2t^2$ is a solution of one-dimensional wave equation.

(c) Distinguish between ripples and gravity waves.

2. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) If a wave of frequency 500 Hz is travelling with a velocity of 200 ms^{-1}, then find the change in phase at a given point in space between a time interval of 10^{-3} sec. Also find the path difference between two points which differ in phase by $\pi/2$ radian. 4

(b) Prove that wave equation for a transverse wave in a string is given by

$$\frac{\delta^2 y}{\delta x^2} = \frac{1}{c^2}\frac{\delta^2 y}{\delta t^2}$$

where $c = \sqrt{\frac{T}{\rho}}$, T being tension and ρ the linear density of the string. 4

(c) What are beats? Show that the number of beats produced per sec is equal to the difference in the frequencies of the two sounding bodies. 4

(d) What are Lissajous figures? How will you trace graphically the Lissajous figures when time periods are equal and phase difference is $\pi/4$? 4

UNIT—II

3. Answer any *two* of the following questions : 1×2=2

(a) Find the temperature at which the velocity of sound in air becomes 1·5 times its value at 0 °C.

(b) What do you understand by phase velocity and group velocity?

(c) Show that the frequency of the fundamental note of an open organ pipe is twice that from a closed pipe of the same length.

4. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Starting from the relation $v = \sqrt{\frac{E}{\rho}}$ for velocity of sound in a gas, show that $v = \sqrt{\frac{\gamma P}{\rho}}$, where P is the pressure and γ is the ratio of specific heat at constant pressure to specific heat at constant volume. 4

(b) Obtain the expression for phase velocity and group velocity in terms of angular frequency and propagation number. 4

(c) Calculate the energy of the S-th vibration of a stretched string plucked at h, the initial displacement of the plucked point being k. 4

(d) Describe Melde's experiment and explain how laws of vibration of strings can be verified with this experiment. 4

UNIT—III

5. Answer any *two* of the following questions : 1×2=2

(a) What are coherent sources? How are they realized in practice?

(b) Why is a broad source of light necessary for observing colours in thin films?

(c) What are temporal and spatial coherences?

6. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Discuss in detail how the wavelength of monochromatic source of light can be determined with the help of Fresnel's biprism. 4

(b) How does interference take place in a thin film? Show that the reflected and the transmitted interference patterns are complimentary. 4

(c) Prove that the diameter of bright rings are proportional to the square root of odd simple numbers and that of dark rings are proportional to the square root of simple numbers in case of Newton's rings. 4

(d) Newton's rings are observed in reflected light of wavelength $5 \cdot 9 \times 10^{-7}$ m. The diameter of 10th dark ring is 0·5 cm. Find the radius of curvature of the lens and thickness of the air film. 4

UNIT—IV

7. Answer any *two* of the following questions : 1×2=2

(a) In Michelson's interferometer 100 fringes cross the field of view when the movable mirror is displaced through 0·02948 mm. Calculate the wavelength of monochromatic light used.

(b) Discuss the statement "A grating having higher dispersive power than another, does not necessarily has a higher resolving power".

(c) State the difference between the grating and the prism spectrum.

8. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Discuss the intensity distribution of Fabry-Perot interferometer fringes and the ratio of I_{max} to I_{min}. 4

(b) Find the expression for the width of the central maximum in case of Fraunhofer diffraction pattern due to single slit. 4

(c) What is a plane diffraction grating? In a plane transmission grating the angle of diffraction for 2nd order maxima for wavelength 5×10^{-5} cm is 30°. Calculate the number of lines in 1 cm of the grating surface. 1+3=4

(d) Derive an expression for the resolving power of a plane transmission grating. 4

UNIT—V

9. Answer any *two* of the following questions : 1×2=2

(a) Explain clearly the difference between interference and diffraction.

(b) What is the difference between holography and photography?

(c) What is the radius of 1st zone of a zone plate of focal length 0·2 m for a light of wavelength 5000 Å?

10. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Distinguish between Fresnel and Fraunhofer type of diffraction. 4

(b) Discuss the phenomenon of diffraction at a straight edge and state how you would determine the wavelength of light from the study of the fringes. 4

(c) What is the meaning of half period zones? Why are they called so? How are they constructed? 4

(d) What is the fundamental principle of hologram? How is it produced and how is the image reconstructed from it? 4

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