Registration No : | | | | | | | | | | |

Total Number of Pages : 02

B.Tech.
RPH1A001

1st Semester Regular/Back Examination: 2021-22
PHYSICS
BRANCH(S): AEIE, AG, AUTO, BIOMED, BIOTECH, CIVIL, CSE, CSEAI, CSEAIME, CST, ECE, EEE, ELECTRICAL, ELECTRICAL & C.E, ELECTRONICS & C.E, ETC, IT, MANUTECH, MECH, METTA, MINING, MME, PLASTIC, PT
Time : 3 Hour
Max Marks : 100
Q.Code : OF648

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions :** **(2×10)**

a) A harmonic wave is represented by the wave function $\psi(x,t) = 3 \sin(0.6x - 2.2t)$. Determine its amplitude, frequency, velocity and wavelength.
b) Prove that the curl of the gradient of a scalar is zero.
c) State and explain Bragg's law.
d) What is a zone plate?
e) Position vector $\boldsymbol{r}$ is irrotational, justify.
f) The electric field between two parallel metal plates of area 3 cm^2, changes at the rate of 1.2×10^8 V/ms. Calculate the displacement current.
g) Compare the de Broglie's wavelengths of an electron and a proton moving with the same energy, where the proton mass is 1840 times the mass of the electron.
h) Name the phenomenon in which energy is converted to matter. Write the equation for conservation of energy in this phenomenon.
i) What are the necessary and the sufficient conditions for the production of LASER?
j) With a neat block diagram, show and explain the components of FOCL.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 × 8)**

a) Using Gauss divergence theorem, show that the volume of a sphere is $4/3\ \pi r^3$
b) Based on the band theory, classify a solid into insulators, semiconductors and conductors with required diagrams.
c) Derive the relation between the magnitudes of electric component **E** and magnetic induction component **B** of an electromagnetic wave. Obtain the SI unit of the ratio of the two components.
d) If the maximum angle of incidence is 52.74° for entrance of light into the optical fiber placed in air; calculate the acceptance angle and the numerical aperture.
e) Derive the expression for the fringe spacing in a two source interference pattern.
f) For a quantum particle of mass 'm', moving along the y-axis with energy 'E', develop the time dependent Schrodinger's wave equation.
g) Explain the working of a four level LASER system with energy level diagram. What are its benefits over a three level LASER system?

h) Newton's rings arrangement is used with a source emitting two wavelengths λ_1 and λ_2. It is found that the n^{th} dark ring due to λ_1 coincides with $(n+1)^{th}$ dark ring due to λ_2. Find the diameter of the n^{th} dark ring for wavelength λ_1=600 nm if λ_2= 590 nm and radius of curvature of the lens is 0.9 m?

i) Normalize the wave function $\psi_n(x) = A \sin(n\pi x/a)$ for $0<x<a$.

j) Using Heisenberg's Uncertainty relation, calculate the ground state energy of a Harmonic Oscillator

k) The time period of a simple harmonic oscillator is 4s. it is subjected to a damping force proportional to its speed with damping co-efficient 0.1/s. find the time period and logarithmic decrement when subjected to damping forces

l) What is tunneling? 1.2 million Electrons with energy 3.0 eV are incident on a potential barrier of 9.0 eV high and 0.5 nm width. How many electrons can tunnel through the barrier?

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 a) With suitable diagram and working formula, describe the method for determination of wavelength of light with Newton's rings experiment. (7)

b) Find the inter-planer spacing for a (321) plane in a simple cubic lattice whose lattice constant is 4.2×10^{-8} cm. (4)

c) State Faraday's laws of electromagnetic induction. Develop its differential form. (5)

Q4 a) State Poynting theorem. Write the direction and S.I unit of Poynting vector. A laser source emits power at rate of 1000 W. Find the average value of Poynting vector at a point 5m ahead of it. (6)

b) Write the laws of photoelectric effect. In an experiment the tungsten cathode with threshold wavelength 2300 A^0 is irradiated by ultra-violet light of wavelength 1800 A^0. Calculate the maximum energy of emitted photoelectrons and work function of the metal. (6)

c) Mention four differences between step index and graded index optical fiber. (4)

Q5 a) Describe in detail the construction and working of a ruby LASER. What are its important applications? (8)

b) Derive the expression for the quantum mechanical energy operator. (3)

c) Derive the Maxwell's electromagnetic wave equations in terms of magnetic vector in a charge free non-conducting medium, identify the dissipative term. (5)

Q6 a) What are normal coordinates? Set up the differential equations of motion of two pendulums of equal masses coupled together by a spring and find out the normal mode frequencies. Discuss the in phase mode and out of phase mode of oscillations. (7)

b) Write three similarities between the zone plate and a convex lens. The diameter of the central zone of a zone plate is 2.3 mm. if a point source of light of wavelength 5893 Å is placed at a distance of 6.0 m from the zone plate, calculate the position of the first image. (5)

c) Derive the differential form of Gauss's law in magnetism. Write its physical significance (4)