UPES
UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Physics I   Semester: II
Program: B. Tech APE-Gas, ADE, Chemical, ME, Mech, FSE, CE   Time : 03 hrs.
Course Code: PHYS1020   Max. Marks: 100

Instructions: Use of scientific calculator is permitted.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Deduce the relationship between dielectric constant and electric susceptibility.	4	CO2
Q 2	Prove that phase velocity exceeds the velocity of light.	4	CO3
Q 3	If an excited atom has maximum uncertainty of 10 ns in its lifetime, what would be the inherent fractional line broadening?	4	CO3
Q 4	A particle limited to the x-axis has the wave function $\Psi = \mathbf{ax}$ between x = 0 and x = 1; $\Psi = \mathbf{0}$ elsewhere. Find: (i) the probability that the particle can be found between x = 0.45 and x = 0.55. (ii) the expectation value $<x>$ of the particle's position.	4	CO3
Q 5	A communication system uses 10 km fibre having a loss of 2.3 dB/km. Compute the output power if the input power is 400 μW	4	CO1

SECTION B
(4Qx10M= 40 Marks)

Q 6	In a simple cubic crystal (i) find the ratio of intercepts of three axes by (1 2 3) plane and (ii) find the ratio of spacings of (1 1 0) and (1 1 1) planes.	10	CO4
Q 7	Starting from Ampere's circuital law, derive the 4th Maxwell equation (modified Ampere's circuital law). Hence find the expression for displacement current density.	10	CO2

Q 8	Describe the following:
	  a. Population inversion
	  b. Pumping techniques
	  c. Metastable states
	     (3+4+3)
		10	CO1

Q 9	Explain the hysteresis curve in ferromagnetic materials.	10	CO2

SECTION-C
(2Qx20M=40 Marks)

Q 10	a. A photon of energy E is scattered by an electron initially at rest (rest mass energy,$_0$) (Compton scattering problem). Show that the maximum kinetic energy (KE_{max}) of the recoil electron can be calculated as $$KE_{max}=\frac{\dfrac{2E^2}{E_0}}{1+\dfrac{2E}{E_0}}$$ (10) b. Derive Schrodinger's time-dependent wave equation. (10) <center>OR</center>a. What is the photoelectric effect? Explain it with the help of different graphs. (10) b. Derive the expression for Eigen wave function for the problem of particle in one dimensional box ? (10)	20	CO3
Q 11	a. Define unit cell and describe different types of Bravais lattices. (10) b. What are Miller indices? Draw the planes $(1\bar{2}1\dot{\iota}$ and (234). (10)	20	CO4

LIST OF IMPORTANT CONSTANTS

Planck's constant, $h = 6.6 \times 10^{-34}$ J.s
Boltzmann's constant, $k = 1.38 \times 10^{-23}$ J/K
Mass of electron, $me = 9.1 \times 10^{-31}$ Kg
Mass of proton, $mp = 1.67 \times 10^{-27}$ Kg
Velocity of light, $c = 3 \times 10^8$ m/s
Rydberg Constant, $R = 1.097 \times 10^7$ m-1
Avogadro's number $= 6.023 \times 10^{23}$
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ Henry/m
Permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Impedance of em wave in free space $Z_0 = 377$ Ohm