Name:

Enrolment No:

UPES

End Semester Examination, December 2025

Course: Physics **Semester: I**

Program: B. Tech SOAE (All branches) **Time : 03 hrs.**

Course Code: PHYS 1038 **Max. Marks: 100**

Instructions: All questions are compulsory. Use of scientific calculator is allowed.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q1	Express smallest allowed magnitude of atomic dipole moment in units of J/T.	**4**	**CO2**
Q2	Establish the relation between group velocity and phase velocity for matter waves.	**4**	**CO2**
Q3	A signal with a power of 5μW is present at the input of a 0.1 km long fibre. If the power at the output end of the fibre is 1 μW, calculate the attenuation coefficient of the fibre	**4**	**CO3**
Q4	A particle limited to the x-axis has the wave function $\Psi = ax$ between x = 0 and x = 1; $\Psi = 0$ elsewhere. Find the probability that the particle can be found between x = 0.45 and x = 0.55	**4**	**CO4**
Q5	Determine the atomic packing factor for a face centered cubic (FCC) crystal structure.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q6	Explain the hysteresis curve exhibited by ferromagnetic materials.	**10**	**CO1**
Q7	Calculate the lowest energy of an electron confined in a cubical box of each side 1Å. Furthermore, find the temperature at which the average energy of the molecules of a perfect gas would be equal to the lowest energy of the electron in the cubical box, $k_B = 1.38\times10^{-23}$ J/K.	**10**	**CO4**
Q8	Deduce the relationship between Einstein's coefficients. OR With the aid of suitable diagrams, explain the construction and working of Ruby Laser.	**10**	**CO1**
Q9	Two parallel plates of capacitor having equal and opposite charges are separated by a 6.0 mm thick dielectric material with a dielectric constant 2.8. If the electric field strength within the dielectric is 10^5 V/m, determine the polarisation vector and the displacement vector in the dielectric.	**10**	**CO3**

SECTION-C (2Qx20M=40 Marks)			
Q10	(a) Establish the following relationship for the direction of recoiling electron in Compton scattering: $\tan\phi = \frac{\cot\frac{\theta}{2}}{1+\frac{h\nu}{m_0c^2}}$, where θ = scattering angle of the photon and ∅ is the angle between the incident photon and the recoiled electron. (10) (b) State the various forms of Heisenberg's uncertainty principle. Explain why electrons cannot reside inside the nucleus? (10) OR (a) Explain the phenomenon of pair production. Also demonstrate the reason why pair production cannot take place in empty space. (10) (b)Derive the time dependent Schrodinger wave equation for a quantum particle starting with classical wave equation. (10)	**20**	**CO2**
Q11	Several characterization techniques employ electromagnetic radiation to study materials. Briefly describe Raman Spectroscopy as a characterization technique. (10) With the aid of a suitable diagram, deduce the expression for interplanar spacing in an orthorhombic crystal. (10)	**20**	**CO3**

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, $\mu o = 4\pi \times 10^{-7}$ Henry/m
Permittivity of free space, $\varepsilon o = 8.85 \times 10^{-12}$ F/m

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