Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: PHYSICS I **Semester: II**
Course Code: PHYS1006
Programme: B.Tech : Electrical, Electronics, ASE, ASE+AVE, ADE, Mechatronics, Civil Chemical
Max. Marks: 100
Time: 03 hrs.
Instructions: All questions are compulsory (**Q7,Q8** and **Q12** have internal choice)
Total pages: 2

SECTION A

S. No.		Marks	CO
Q1.	Show that a photon and electron of the same momentum have the same wavelength. Compare their wavelengths if the two have same energy.	**4**	**CO1**
Q2.	An electron has a speed of 1.05×10^{4} m/sec within the accuracy of 0.01%. Calculate the uncertainty in the position of the electron.	**4**	**CO1**
Q3.	Write short notes on translational and rotational symmetry operations in crystallography.	**4**	**CO2**
Q4.	The magnitude of field vector $\overline{H}$ at a distance of 1 meter from a infinitely long conductor is 2 amp/meter. Find the current in the wire.	**4**	**CO3**
Q5.	Write both the differential and integral form of the Maxwell's equations with its physical significance.	**4**	**CO3**

SECTION B

Q6.	What is the significance of Schrodinger equation in Quantum Mechanics. Deduce the time independent Schrodinger wave equation.	**8**	**CO1**
Q7.	Calculate the expectation value of position 'x' & momentum 'p_x' for a particle moving in one dimensional box of length L. **OR** Obtain the normalized wave function for a particle of mass m moving in a one dimension box of length L.	**8**	**CO1**

Q8.	Deduce the equation of continuity $\frac{\partial \rho}{\partial t}=-\vec{\nabla}\cdot\vec{J}$ and discus its physical significance. **OR** A parallel plate capacitor with plate area A and plate separation $d$is charged by a constant current I. Consider a plane surface of area $A/3$ parallel to the plates and drawn symmetrically between the plates. Find the displacement current through this area.	**8**	**CO3**
Q9.	[a] If a NaCl crystal is subjected to an electric field of 1000 V/m and the resulting polarization is 4.3×10^{-8} C/m^2, calculate the relative permittivity of NaCl. [b] Calculate the electronic polarizability of argon atom. Given $K=\varepsilon_r=1.0024$ at NTP and $N=2.7\times 10^{25}\,m^{-3}$.	**8**	**CO3**
Q10.	From the diameter and effective surface temperature of the sun, estimate the rate of which it emits energy. What fraction of this emitted energy is intercepted by the earth? Estimate the solar constant. (*Given*: Diameter of the sun = $1.39\times 10^9\,m$; Temperature of surface of sun = $5800\,K$; Mean earth-sun distance = $1.495\times 10^{11}\,m$).	**8**	**CO4**
	SECTION-C		
Q11.	[a] Define the packing fraction of a crystal. Obtain an expression for the packing fraction for the 'hcp' structure. [b] An X-ray beam of wavelength 0.71 Å is diffracted by a cubic KCl crystal of density 1.99×10^3 kg-m^{-3}. Calculate the interplanar spacing for (200) planes and the glancing angle for the second order reflection from these planes. The molecular weight of KCl is 74.6 amu and the Avogadro's number is 6.023×10^{26} kg^{-1} mole^{-1}.	**10** **10**	**CO2** **CO2**
Q12.	[a] What are polar and non-polar dielectrics? Derive the Clausius-Mossotti relation expressing the relationship between dielectric constant and atomic polarizability. [b] Define photovoltaic effect. Explain the construction and working of a solar cell with its I-V characteristics. **OR** [a] Define magnetic susceptibility χ) and relative magnetic permeability (μ_r) and establish a relation $\mu_r=\mu_0(1+\chi)$. [b] Write short notes on the following: 1. Fill factor 2. Maximum power point 3. Efficiency of a solar cell.	**10** **10** **10** **10**	**CO3** **CO4** **CO3** **CO4**

Physical constants: $h = 6.63 \times 10^{-34}\, J-s, c = 3 \times 10^{8}\, m/s, k_B = 1.38 \times 10^{-23}\, J/K, \mu_0 = 4\pi \times 10^{-7}\, H/m$ $\varepsilon_0 = 8.854 \times 10^{-12}\, F/m,\ \sigma = 5.67 \times 10^{-8}\, W.m^{-2}K^{-4}$

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Total pages: 2

SECTION A

S. No.		**Marks**	**CO**
Q1.	Explain how de-Broglie proposed his relation (λ=h/p) i.e. a moving materialistic particle have a wave-like behavior. The symbols have their usual meanings.	**4**	**CO1**

Q2.	Based on the concepts of quantum mechanics, calculate the lowest possible energy of an electron confined in a cubical box of each side equal to 10^{-10} meter.	**4**	**CO1**
Q3.	Crystal structure is identify by a diffraction method. Among powder X-ray, electron and neutron diffraction methods, explain which method is best and why.	**4**	**CO2**
Q4.	Discuss magnetic hysteresis briefly, and define hard and soft ferromagnetic magnetic materials based on hysteresis curve.	**4**	**CO3**
Q5.	A point charge of 0.6 C is at the centre of imaginary hollow cube filled with free space. Find the total electrical flux passing through from one face of the cube.	**4**	**CO3**
	SECTION B		
Q6.	Describe pair production and pair annihilation phenomena, and hence prove that pair production cannot occurs in empty space.	**8**	**CO1**
Q7.	An electron is trapped in a 1D infinitely deep potential well of width $L = 10^{-9}$ m. Calculate the wavelength of photon emitted from the transition $E_4 \rightarrow E_3$.	**8**	**CO1**
Q8.	Explain the concept of displacement current, and describe how it helps in modifying Ampere's circuital law.	**8**	**CO3**
Q9.	A monoatomic gas contains 3×10^{25} atoms/m^3 at 1 atmospheric pressure and at room temperature (27 ^{0}C). The radius of gaseous atoms is 0.2 nm. Find the dipole moment per unit electric field, polarization, dielectric constant and polarizability of this gas. **OR** Three identical small spheres of mass (m) are suspended in air from a common point by threads of negligible masses and equal length *l*. A charge Q is divided equally among spheres, and they come to equilibrium at the corners of a horizontal equilateral triangle whose sides are d. Show that $Q^2 = 12\pi\varepsilon_0 mgd^3[l^2-\frac{d2}{3}]^{-1/2}$, g = acceleration due to gravity.	**8**	**CO3**
Q10.	Write short notes on the following: 4. Fill factor 5. Maximum power point 6. Efficiency of a solar cell **OR** Describe various factors affecting the short circuit current of a photovoltaic solar cell.	**8**	**CO4**
	SECTION-C		
Q11.	(a) Using classical free electron theory, derive expression for conductivity (σ) of	**10**	

	a given conductor. ($\sigma = \frac{ne^2\tau}{m}$; where n= carrier concentration per unit volume, τ=relaxation time, m=rest mass of electron)		**CO2**
	(b) The atomic weight and density of Na are 23 and 1.83 gm/cm^3 respectively. The electronic polarizability of the atoms is 2.39x10^{-40} F-m^2**.** If Na solid has cubical symmetry, what will be its' relative dielectric constant.	**10**	**CO2**
Q12.	(a) Write generalized (differential & integral) form of four Maxwell's equations. (b) Explain working principle and I-V characteristics of a single crystalline solar cell, and hence describe the various loss mechanisms.	**10** **10**	**CO3** **CO4**
	OR		
	(a) Derive expression for continuity equation ($\vec{\nabla} \cdot \vec{J} = \frac{-\partial \rho}{\partial t}$, where symbols have their usual meanings. (b) Describe and explain in details the terms solar cell arrays and PV modules.	**10** **10**	**CO3** **CO4**
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