UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2018

Course: **Physics II** Semester: **II**

Course Code: **PHYS1004**

Program: **B.Tech (SOE)**

Time: **03 hrs.** **Max. Marks: 100**

Instructions:

1. **All questions are compulsory.**
2. **This question paper has three sections; Section A, Section B, and Section C**
3. **In section A there are total 5 questions, each carrying 4 marks**
4. **In Section B there are total 4 questions, each carrying 10 marks. Question no. 9 is having an internal choice.**
5. **In Section C there are total 2 questions, each carrying 20 marks. Question no. 11 is having internal choice.**
6. **Draw suitable diagrams wherever required.**
7. **Your answer should be concise and to the point.**
8. **The CO's represents Course Outcomes which are for official purpose.**

SECTION A

S. No.		Marks	CO
Q 1	Deduce the expression for time dilation using the Lorentz transformation equations.	4	CO1
Q 2	Estimate the energy of the electrons that we need to use in an electron microscope to resolve a separation of 0.27nm.	4	CO2
Q 3	Discuss the basic assumption of Planck's radiation law for black body radiations. (*Maximum 50 words*).	4	CO1
Q 4	Illustrate that in a system of fermions at T=0 K, all the states of $E<E_F$ are occupied and all states $E>E_F$ are unoccupied.	4	CO1
Q 5	Define Bohr magneton. Discuss the temperature variation of paramagnetic and diamagnetic susceptibilities of materials.	4	CO1

SECTION B

S. No.		Marks	CO
Q 6	**i.** Discuss the classical and quantum approach to explain specific heat of solids. Derive the formula for specific heat of solids using quantum approach (Einstein Formula). **ii.** A Ge semiconductor diode carries a current of 1 mA at room temperature when a forward bias of 0.15 V is applied, estimate the reverse saturation current at room temperature.	5 5	CO2
Q 7	Explain various polarization mechanisms in a non-polar dielectric. For a dielectric material with $\epsilon_r = 3.6$ and $D = 285 nC\, m^{-2}$, find the magnitudes of $E, P \wedge \chi_e$.	5+5	CO2
Q 8	**i.** A square of area 100 cm^2 is at rest in the frame of reference of S. Observer S'	5+5	CO3

	moves relative to S at 0.8c and parallel to one side of the square. Determine the area as measured by S' observer. **ii.** Consider an intrinsic Si (density=2.33 $gm¿$, $n_i = 1.5 \times 10^{16} m^{-3}$, atomic weight = 28.09 amu) with electron mobility $\mu_n = 0.135 m^2 V^{-1} s^{-1}$. If the Si is doped with one pentavalent impurity for each 10^7 Si atoms. Determine the concentration of electrons (n), holes (p) and conductivity (σ).		
Q 9	Derive an expression for allowed energies for a particle in one-dimensional box of length L (infinite potential barrier). Write the normalized wave function and sketch the allowed wave-functions and probability densities for n=1, 2 and 3. **OR** **i.** Discuss the essential properties of a "well behaved" wave function, representing a quantum-mechanical object. **ii.** For pair production to occur charge, momentum and energy should be conserved. Considering only charge and energy conservation, will it be possible for pair- production to occur in empty space?	**10** **5+5**	**CO2**
	SECTION-C		
Q 10 (a)	Define anti-ferroelectricity and ferroelectricity. Obtain the relationship between the macroscopic dielectric constant and polarizabilities (Clausis-Mosotti equation) using internal (Lorentz) field at an atom in cubic structure $\left(E_L = E + \frac{P}{3\epsilon_0}\right)$.	**10**	**CO3**
Q 10 (b)	**i.** The sun mass is $2.0 \times 10^{30} Kg$, its radius is $7.0 \times 10^{8} m$, and its surface temperature is $5.8 \times 10^{3} K$. How many years are needed for the sun to lose 0.02 % of its mass by radiation? **ii.** The density of Aluminium (Al) is 2.7 gm cm^{-3} and its atomic mass is 26.97 a.m.u. The Al ions in metal are in Al^{+3} states and the effective mass of an electron in Al is 0.97 m_e. Calculate its Fermi Energy in eV.	**5+5**	**CO4**
Q 11	**i.** Using suitable diagram explain the phenomenon of Hall Effect. Also, find the expression for Hall Coefficient, $R_H = \frac{V_H b}{IB}$, where V_H=Hall voltage, I = current, B= applied magnetic field, and b is dimension along the direction of applied magnetic field. Highlight any two applications. **ii.** A photon of energy 4.25 eV strikes the surface of a metal **A**, the ejected photoelectrons have kinetic energy, KE_A eV and de-Broglie wavelength λ_A.	**10** **10**	**CO3**

	The maximum KE of photoelectrons liberated from another metal **B** by the photon of energy 4.7 eV is $KE_B = (KE_A - 1.5)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then what are the kinetic energies (KE_A and KE_B) of ejected photoelectrons and work functions of two metals? **OR**. **i.** Using diode equation (Shockley equation) explain the V-I characteristics of a semiconductor p-n junction diode in forward and reverse bias. Describe the process of (a) Avalanche and (b) Zener Breakdown in a p-n junction diode. **ii.** Write the Lorentz transformation equations. Show that if two events are simultaneous in both space and time (happening at same time and same place) in an inertial frame will also be simultaneous in another inertial frame moving relative to it.	**10** **10**	

Values of some physical constants:

Velocity of light, $c = 3 \times 10^{8}\, m\, s^{-1}$

Charge of electron, $e = 1.6 \times 10^{-19} C$

Mass of electron, $m_e = 9.1 \times 10^{-31} kg$;

Mass of proton/neutron =1 a.m.u.¿ $1.67 \times 10^{-27} kg$

Boltzmann Constant (K_B) = $1.38 \times 10^{-23} J\, K^{-1}$

Planck's Constant (h) = 6.6×10^{-34} Jsec;

Permittivity of free space (ϵ_0 ¿ $= 8.854 \times 10^{-12} F\, m^{-1}$

Permeability of free space (μ_0 ¿ $= 4\pi \times 10^{-7} H\, m^{-1}$

Stefan-Boltzmann constant (σ)= $5.67 \times 10^{-8} W\, m^{-2} K^{-4}$

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	OR (a) Discuss electronic, ionic, orientational polarization with suitable diagram. (b) Si is doped with pentavalent impurity of concentration of 10^{21} /m^3 to make Si n-type. Calculate conductivity of doped Si if drift velocity of electron is 10^4 m/s for an applied electric field of 10 KV /m.	**10** **10**	**CO2** **CO4**

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