VIT-AP UNIVERSITY	Final Assessment Test – Winter (2024-25) Freshers - May 2025	
	Maximum Marks: 100	Duration: 3 Hours
Course Code: PHY1008	Course Title: Modern Physics	School: SAS
Set No: 07	Exam Type : **Closed Book**	Session: FN
Date: 21/05/2025	Slot: B_1	

Keeping mobile phone/smart watch, even in 'off' position is treated as exam malpractice

General Instructions if any:

1. "*fx* series" - non-Programmable calculator are permitted: YES

2. Reference tables permitted: NO

3. Use the following values, $h = 6.63 \times 10^{-34}$ J s, $e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg, $m_n = 1.67 \times 10^{-27}$ kg, $m_p = 1.67 \times 10^{-27}$ kg, $c = 3 \times 10^8$ m/s, 1 eV $= 1.6 \times 10^{-19}$ J, $k_B = 1.38 \times 10^{-23}$ J K^{-1} $= 8.617 \times 10^{-5}$ eV K^{-1}, $\mu_0 = 4\pi \times 10^{-7}$ H/m , Avogadro Number $(N_A) = 6.023 \times 10^{23}$/mol, Bohr Magneton ($\mu_B$ or β) $= 9.27 \times 10^{-24}$ A m^2, wherever required.

Answer any TEN Questions, Each Question Carries 10 Marks (10×10=100 Marks)

1. In Young's double-slit experiment, blue light with a wavelength of 480 nm produces a second-order bright fringe at a particular point on the screen. What wavelength of visible light would result in a dark fringe appearing at that same location? **(10 M)**

2. Determine the minimum thickness of an air film trapped between two flat glass plates (refractive index of glass = 1.50) such that the reflected light appears bright under normal incidence of 450 nm wavelength. Additionally, calculate the required minimum thickness for the reflected light to appear dark under the same conditions. **(10 M)**

3. A hydrogen discharge lamp emits its two most prominent wavelengths at 656 nm (red) and 486 nm (blue). This light is directed onto a diffraction grating with a line density of 500 lines/mm. If the resulting diffraction pattern is observed on a screen positioned 1.50 meters behind the grating, calculate the linear distance between the first-order red and blue fringes on the screen. **(10 M)**

4. An astronomical reflecting telescope with a primary mirror diameter of 0.25 meters is used to observe fine details on the Moon's surface. The telescope operates under visible light with a wavelength of 550 nm. (a) Calculate the minimum angular separation the telescope can resolve using the Rayleigh criterion. (b) What is the resolving power of the telescope? **(10 M)**

5. A 12-gram bullet is fired from a rifle at a velocity of 150 m/s. (a) Calculate the de Broglie wavelength associated with the bullet. (b) Given that the position of the bullet is known with a precision of 0.60 cm (the radius of the barrel), determine the minimum uncertainty in its momentum. **(10 M)**

6. An electron is confined in a one-dimensional box with a length of 0.600 nm. During a transition between two energy levels, a photon with an energy of 8.36 eV is emitted. Determine the two energy levels involved in this transition. **(10 M)**

7. In a plasma, the phase velocity of an electromagnetic wave is given $v_p = \frac{C}{\sqrt{1+\beta\lambda^2}}$ where β is a constant, C is the speed of light and λ is the wavelength of the wave. (a) Derive the expression for the group velocity. (b) If $\beta = 3\times10^{-7}\ m^{-2}$ and $\lambda = 400$ nm, calculate the phase velocity. **(10 M)**

8. A silicon crystal exhibits an intrinsic carrier concentration of $1.5\times10^{10}\ cm^{-3}$, with electron mobility of 1350 $cm^2/V\cdot s$, and a hole mobility of 480 $cm^2/V\cdot s$. (a) Compute the electrical conductivity of the intrinsic silicon. (b) If donor doping increases the electron concentration to $10^{17}\ cm^{-3}$, determine the resulting electrical conductivity of the n-type silicon. **(10 M)**

9. At a temperature of 300 K, a silicon crystal has a bandgap energy of 1.12 eV. The effective density of states in the conduction band is $N_c = 2.8\times10^{19}\ cm^{-3}$, and in the valence band is $N_v = 1.04\times10^{19}\ cm^{-3}$. Calculate the intrinsic carrier concentration and the hole concentration in intrinsic silicon at this temperature. **(10 M)**

10. Red LEDs were developed earlier than green and blue LEDs due to differences in material properties. Estimate the energy bandgaps associated with green (525 nm) and blue (465 nm) light emissions in LED applications. **(10 M)**

11. A magnetic data storage device utilizes a coating of material with a relative permeability of $\mu_r = 120$ applied to the recording surface. During operation, the write head generates a magnetic field intensity of H = 1000 A/m in the region of the coating. (a) Determine the magnetic susceptibility χ and the magnetization M of the coating material. (b) Calculate the magnetic flux density B within the coating material. **(10 M)**

12. A paramagnetic material obeys Curie's Law and its magnetic susceptibility at 300 K is found to be 0.012. (a) Compute the Curie constant associated with the material. (b) At what temperature will the magnetic susceptibility reduce by 40% from its value at 300 K? **(10 M)**

QP MAPPING

Q. No.	E/A/T	Module Number	Marks	BL	CO Mapped	PO Mapped	PEO Mapped	PSO Mapped
Q1	A	1	10	2	CO1	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q2	A	1	10	3	CO1	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q3	T	2	10	4	CO1	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q4	E	2	10	2	CO1	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q5	E	3	10	2	CO2	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q6	A	3	10	2	CO2	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q7	T	3	10	4	CO2	1, 2, 3, 4, 5	1,2,3,4	1, 2, 3
Q8	A	4	10	3	CO3	1, 2, 3, 4, 5, 6, 7	1,2,3,4	1, 2, 3
Q9	T	4	10	4	CO3	1, 2, 3, 4, 5, 6, 7	1,2,3,4	1, 2, 3
Q10	A	4	10	3	CO3	1, 2, 3, 4, 5, 6, 7	1,2,3,4	1, 2, 3
Q11	E	5	10	2	CO4	1, 2, 3, 4, 5, 6, 7	1,2,3,4	1, 2, 3
Q12	A	5	10	3	CO4	1, 2, 3, 4, 5, 6, 7	1,2,3,4	1, 2, 3