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| Name: |  |
| Enrolment No: | |

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, January 2021

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| Course: PHYSICS I Course Code: PHYS1020 Programme: BTech :APE UP, EC, EE, ASE, ASE+AVE Total pages: 2 | Semester: I Max. Marks: 100 Time: 03 hrs. |
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Instructions:

- All questions are compulsory (**Q12** has internal choice)
- Use blank paper as rough work to solve the questions in section-A and write only the correct options (type answers, no upload)

SECTION A

| S. No. | | Marks | CO |
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| Q1. | Write down the characteristics of a laser beam | 5 | CO1 |
| Q2. | Magnetization of a paramagnetic salt at temperature 300K in a magnetic field of 0.4 T (Curie's constant is 3×10^{-3} K) is (a) 3.5 A/m (b) (3.2 A/m) (c) 3.6 A/m (d) 3.8 A/m | 5 | CO2 |
| Q3. | The Displacement current density \vec{J}_d from the given electric field, $\vec{E} = E_0 \sin(kx - 10^{12}t)\hat{j}$ associated with an electromagnetic wave travelling through a medium of relative dielectric permittivity 2 will be (a) $\vec{J}_d = 17.7 E_0 \cos(kx - 10^{12}t)\hat{j} A/m^2$ (b) $\vec{J}_d = 1.77 E_0 \cos(kx - 10^{12}t)\hat{j} A/m^2$ (c) $\vec{J}_d = 177 E_0 \cos(kx - 10^{12}t)\hat{j} A/m^2$ (d) $\vec{J}_d = 17.7 E_0 \sin(kx - 10^{12}t)\hat{j} A/m^2$ | 5 | CO2 |
| Q4. | Choose the correct normalization constant N for $\Psi(x) = Ne^{-x^2/a^2}$ as (a) $N = \sqrt{\frac{1}{2a\pi}}$ (b) $N = \sqrt{\frac{1}{a\sqrt{2\pi}}}$ (c) $N = \sqrt{\frac{1}{a} \sqrt{\frac{2}{\pi}}}$ (d) $N = \sqrt{\frac{1}{2a\sqrt{\pi}}}$ | 5 | CO3 |
| Q5. | A plane with Miller indices of [102] cuts the crystal axes X, Y, Z with the intercepts of a, b, c. The correct intercepts are (a) (2, ∞ , 1) (b) (1, ∞ , 2) (c) (∞ , 1, 2) (d) (∞ , 2, 1) | 5 | CO4 |
| Q6. | Choose the correct ratio of atomic radius (r) to lattice constant (a) of a BCC crystal as (a) $r/a = \sqrt{3/18}$ (b) $r/a = \sqrt{3/8}$ (c) $r/a = \sqrt{3/4}$ (d) $r/a = \sqrt{3/16}$ | 5 | CO4 |

| SECTION B | | | |
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| Q7. | Describe construction and working of He-Ne laser. | 10 | CO1 |
| Q8. | Deduce relation between Einstein A and B coefficients describing the processes of absorption, spontaneous emission, and stimulated emission. | 10 | CO1 |
| Q9. | Prove that an electromagnetic wave propagating in free space follows $\vec{k} \times \vec{E} = \omega \vec{B}$ (you may consider, \vec{E} along X, \vec{B} along Y and propagation along Z directions). | 10 | CO2 |
| Q10. | Give the construction and working of a Solar Cell. | 10 | CO3 |
| Q11. | What is Atomic Packing Fraction (APF)? Obtain APF for FCC crystal. | 10 | CO4 |
| SECTION-C | | | |
| Q12. | (a) Derive Schrodinger time independent wave equation. | 10 | CO3 |
| | (b) Find the probability of finding a particle trapped in a 1D box of length L between L/4 to L/2 using ground state wave function. | 10 | CO3 |
| | OR | | |
| | (a) Derive the expression for Compton shift. | 10 | CO3 |
| | (b) Calculate minimum uncertainty in its position if an electron moves with a speed of 0.02c. Maximum uncertainty in speed = 0.01%. | 10 | CO3 |
| Physical constants: $h = 6.63 \times 10^{-34} \text{ J-s}$, $c = 3 \times 10^8 \text{ m/s}$, $k_B = 1.38 \times 10^{-23} \text{ J/K}$, $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$ $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$, mass of proton = $1.6726 \times 10^{-27} \text{ Kg}$ | | | |