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# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## May 2023 Semester End Main Examinations

**Programme: B.E.** **Semester: I / II**
**Branch: Common to all Branches** **Duration: 3 hrs.**
**Course Code: 21PY1BSPHY / 21PY2BSPHY** **Max Marks: 100**
**Course: Engineering Physics** **Date: 20.05.2023**

**Instructions**: Answer any FIVE full questions, choosing one full question from each unit.

**Physical constants:**

Planck's constant, $h=6.627\times10^{-34}$ J-s Electronic charge, $e=1.602\times10^{-19}$ C
Mass of electron, $m_e=9.1\times10^{-31}$ kg Mass of proton/neutron, $m_p= m_n=1.67\times10^{-27}$ kg
Speed of light, $c=3\times10^{8}$ m/s Avogadro number, $A=6.023\times10^{26}$ kg/mol
Boltzmann's constant, $k=1.38\times10^{-23}$ J/K Permittivity of free space $\epsilon_o=8.85\times10^{-12}$ F/m

**UNIT - I**

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|---|---|---|---|---|
| 1 | a) | Define group velocity. Derive an expression for group velocity on the basis of superposition of waves. | **8** |
| | b) | Using Schrodinger wave equation, derive a normalized eigen function for a particle in one-dimensional potential well of infinite height. | **8** |
| | c) | In a measurement of position and momentum that involved an uncertainty of 0.003%, the speed of an electron was found to be 800 m/s. Calculate the corresponding uncertainty that arises in determining its position. | **4** |

**OR**

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|---|---|---|---|---|
| 2 | a) | State Heisenberg's uncertainty principle. Using this principle, prove that an electron does not exist inside the nucleus. | **8** |
| | b) | What are the characteristics of matter waves? Show that the group velocity of a matter wave is equal to its particle velocity. | **8** |
| | c) | An electron is present in an infinitely deep potential well of width 1.5 Å. Calculate its energy in first three states. | **4** |

**UNIT 2**

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|---|---|---|---|---|
| 3 | a) | Describe the construction and working of semiconductor laser with an energy band diagram. | **8** |
| | b) | Define numerical aperture. Derive an expression for numerical aperture of an optical fiber. | **8** |
| | c) | A ruby laser emits pulses of 20 ns duration with average power per pulse is 0.1 MW. If the number of photons in each pulse is $6.981 \times 10^{15}$, calculate its wavelength. | **4** |

**OR**

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|---|---|---|---|
| 4 | a) | Derive an expression for energy density of radiation in terms of Einstein's A and B coefficients. | **8** |
| | b) | Describe the different types of optical fibers with suitable diagrams. | **9** |
| | c) | Find the attenuation in an optical fiber of length 500 m, when a light signal of power 100 mW emerges out of the fiber with a power 90 mW. | **3** |

**UNIT 3**

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|---|---|---|---|
| 5 | a) | State Wiedemann-Franz law. Calculate Lorentz number using classical and quantum approach. | **8** |
| | b) | What is Fermi factor? Explain with suitable graph, the variation of Fermi factor with temperature. | **8** |
| | c) | A copper rod 19 cm long and 0.785 $cm^2$ cross-section thermally insulated is heated at one end through 100 °C while the other end is kept at 30 °C. If the amount of heat flowing through the rod in 10 minutes is 6.6 kJ, calculate the thermal conductivity of copper. | **4** |

**UNIT 4**

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|---|---|---|---|
| 6 | a) | Explain electronic polarizability and derive a suitable expression for the same. | **8** |
| | b) | What is Hall effect? Derive an expression for Hall voltage and Hall Coefficient. | **8** |
| | c) | An elemental solid dielectric material has polarizability of $7 \times 10^{-40}$ $Fm^2$. Assuming the internal field to be Lorentz field, calculate the dielectric constant for the material if the material has $3 \times 10^{28}$ atoms/$m^3$. | **4** |

**UNIT 5**

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|---|---|---|---|
| 7 | a) | What are forced oscillations? Arrive at the expression for amplitude in case of forced oscillations. | **8** |
| | b) | Define relaxation time and quality factor and mention their expression. Explain sharpness of resonance showing the variation of amplitude with forcing frequency. | **8** |
| | c) | An electric motor weighing 50 kg is mounted on 4 springs each of which has a spring constant of $2 \times 10^3$ N/m. The motor moves only in vertical direction. Find the natural frequency and time period of oscillation. | **4** |

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