Department of Physics

**B.Tech First Year I Semester-2022-23**

**QUESTION BANK**

**Subject/Course: Applied Physics**

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| | **UNIT-I (Wave Optics)** |
| | **SHORT ANSWER QUESTIONS** |
| 1 | Write the principle of superposition. |
| 2 | What is interference of light? |
| 3 | Write the conditions for constructive and destructive interference. |
| 4 | Two interfering beams have amplitude ratios of 2:1, calculate the intensity ratio of bright and dark fringes. |
| 5 | Write the conditions to produce sustained interference. |
| 6 | Two waves having their intensities in the ratio of 9:1 produce interference. Determine the ratio of maxima to minima in the interference pattern. |
| 7 | Define phase difference and write its relation with path difference. |
| 8 | What are coherent sources and how they are realized in practice. |
| 9 | If phase difference between two waves is 2 nπ, then find out path difference between them. |
| 10 | Define resolving power of a plane grating. |
| 11 | What is grating element? |
| 12 | Define Diffraction. |
| 13 | Write the conditions required to observe diffraction pattern. |
| 14 | Differentiate interference and diffraction. |
| 15 | Differentiate Fresnel and Fraunhofer diffraction. |
| 16 | On what factors do the width of central fringe depends in a single slit diffraction pattern? |
| 17 | For a grating of grating element 2μm, calculate the maximum number of orders of diffraction pattern that can be seen for the wavelength 5890 Å. |
| 18 | Define plane of polarization and plane of vibration. |
| 19 | Explain double refraction in calcite crystal. |
| 20 | Why do we get dark ring at the center of the Newton's rings? |
| 21 | Define polarization and write any two applications of polarization. |
| | **LONG ANSWER QUESTIONS** |
| 1 | Write about superposition principle, interference and discuss the conditions for sustained interference. |
| 2 | a) Explain interference in thin film on reflection with a neat diagram and derive the condition for dark and bright fringe.<br>b) A soap film of thickness $5x10^{-5}$ cm is viewed at an angle of $35^0$ to the normal. |

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| | Find the wavelengths of visible light that will be absent from the reflected light($\mu$=1.33) |
| 3 | What is the thickness of the thinnest film of 1.33 refractive index in which destructive interference of yellow light (6000 Å) of a normally incident beam in air can take place by reflection? |
| 4 | a) Explain the formation of Newton's rings with suitable theory.<br>b) A convex lens on a plane glass plate is exposed to monochromatic light. The diameter of the $10^{th}$ dark ring is 0.433 cm. Find the wavelength of light used if the curvature of the lens is 70 cm. |
| 5 | a) Derive the formula $\lambda = \frac{D_m^2 - D_n^2}{4R(m-n)}$ where $D_m$ and $D_n$, the diameters of $m^{th}$ and $n^{th}$ Newtonrings.<br>b) In case of Newton's rings experiment, wavelength of light source is 5400 Å and the radius of the $8^{th}$ dark ring is $3.6 \times 10^{-3}$m. Find the radius of curvature of the lens. |
| 6 | a) Discuss in detail about Fraunhofer diffraction due to single slit.<br>b) The first diffraction minima due to a single slit is at $\theta = 30°$ for a light of wavelength 5000 Å Find the width of the slit. |
| 7 | a) Write the theory of diffraction due to N-slits (Grating).<br>b) For a grating, the angle of diffraction for the second order principal maximum for the wave length $5 \times 10^{-5}$ cm is 30°. Find the number of lines per cm of the grating. |
| 8 | Derive the equation to determine the wavelength of light source using diffraction grating Theory. |
| 9 | Describe the construction and working of a Nicol's prism. |
| 10 | What is polarization? Write some applications of Polarization. |

| **UNIT-II (Introduction to Quantum Mechanics and band theory of solids)** | |
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| | **SHORT ANSWER QUESTIONS** |
| 1 | Write the postulates of Planck's radiation law. |
| 2 | Write the Planck's expression for spectral distribution of black body radiation and its importance. |
| 3 | Discuss the de-Broglie hypothesis of matter particles. |
| 4 | Write the different forms of de-Broglie's equation for wavelength of matter wave. |
| 5 | Determine the wavelength of matter wave associated with electron accelerated by a potential of 100V. |
| 6 | Determine the wavelength of matter wave associated with a ball of mass 200gm. and moving with a velocity of 120 km/sec. |
| 7 | Write the properties of matter waves. |
| 8 | Write time independent Schrodinger wave equation for a free particle. |
| 9 | Calculate the minimum energy of a particle of mass $6 \times 10^{-34}$ Kg enclosed in a 1-D box of width 1.2 Å. |
| 10 | Calculate the wavelength associated with an electron with energy 2000 eV. |
| 11 | An electron is bound in 1 dimensional box of size 4 X $10^{-10}$ m., what will be its minimum energy? |
| 12 | Write the expression for Fermi-distribution function. Show that at all temperatures (T>0K) probability of occupancy of Fermi level is 50% |
| 13 | Write the postulates of Lorentz-Drude free electron theory. |

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| 14 | Write the merits of classical free electron theory. |
| 15 | Write the limitations of classical free electron theory. |
| 16 | Discuss the motion of electrons in a periodic potential. |
| 17 | Write the conclusions of Kronig-Penny model. |
| 18 | Draw E-K diagram for semiconductor. |
| 19 | Define effective mass of an electron and write the expression for effective mass of electron. |
| 20 | Write the values of energy gap of semiconductors and insulators with examples. |
| 21 | Draw the energy band diagrams of metals, semiconductors and insulators. |
| **LONG ANSWER QUESTIONS** | |
| 1 | Describe the concept of de-Broglie hypothesis of matter waves and derive the expressions<br>Derive the following equations<br>$\lambda = \frac{h}{p}, \quad \lambda = \frac{h}{\sqrt{2mE}}, \ \lambda = \frac{12.26}{\sqrt{V}}.$ |
| 2 | Derive Schrodinger time independent wave equation. |
| 3 | Explain the physical significance of wave function. |
| 4 | Show that the energies of a particle in a1-D box are quantized. |
| 5 | Derive wave function for the particle which is moving in one- dimensional potential box |
| 6 | Explain the Fermi-Dirac distribution function for electrons in a metal and discuss it's variation with temperature. |
| 7 | Explain classical free electron theory and discuss merits and demerits. |
| 8 | Discuss the Kronig-Penny model for the motion of an electron in a periodic potential. |
| 9 | a) Draw E-K diagram for a semiconductor and identify various Brillouin zones<br>b) Explain the conclusions of Kronig-Penny model. |
| 10 | Derive an expression for effective mass of an electron. |
| 11 | Explain the origin of energy bands formation in solids and classify metals, semiconductors and insulators based on band theory. |

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| **UNIT-III (Semiconductors and semiconductor devices)** | |
| **SHORT ANSWER QUESTIONS** | |
| 1 | Write a note on doping of semiconductors, its need and outcome. |
| 2 | Distinguish between intrinsic and extrinsic semiconductors |
| 3 | Differentiate N-type and P-type semiconductors. |
| 4 | Explain the effect of temperature on the conductivity of conductors and semiconductors. |
| 5 | Draw the energy band diagrams for<br>i) intrinsic semiconductor<br>ii) n-type semiconductor<br>iii) p-type semiconductor |
| 6 | What are direct and indirect band gap semiconductors? |
| 7 | Draw the E-k graph of direct and indirect band gap semiconductors. |
| 8 | Draw the energy level diagram of PN junction. |
| 9 | What are minority carriers in a PN junction diode and how they are related to reverse current? |
| 10 | Write the basic principle of photodiode. |
| 11 | Write any two applications of Photo diode. |

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| 12 | Draw the I-V Characteristics of photodiode. |
| 13 | Write the applications of solar cell |
| 14 | Define efficiency of solar cell. |
| 15 | Mention the factors responsible for efficiency of solar cell. |
| 16 | Discuss the basic principle of LED. |
| 17 | List out the advantages of LED and specific applications of LED. |
| 18 | Calculate the wavelength of radiation emitted by LED made up of GaAs with band gap energy 1.43 eV |
| 19 | What is Hall Effect? |
| 20 | Write some applications of Hall Effect. |
| 21 | A silicon plate of thickness 1mm, breadth l0mm and length 100mm is placed in perpendicular magnetic field of 0.5 $Wb/m^2$. If $10^{-2}$ A current flow along its length, calculate the Hall voltage developed if the Hall coefficient is $3.66x10^{-4}m^3$/coulomb. |
| **LONG ANSWER QUESTIONS** | |
| 1 | Explain Intrinsic and Extrinsic semiconductors in detail with band diagram and position of fermi level. |
| 2 | Explain direct and indirect band gap semiconductors with the E-k graphs. |
| 3 | Explain the formation of PN junction. |
| 4 | Draw the energy level diagram of PN junction and explain. |
| 5 | Draw the V-I characteristic curve of a PN junction diode and explain. |
| 6 | Explain the construction, working and characteristics of Photo diode. |
| 7 | Explain the construction, working and characteristics of Solar cell. |
| 8 | Explain the construction, working and characteristics of LED. |
| 9 | Explain Hall Effect and derive the expression for Hall coefficient. |
| 10 | Write about various applications of Hall effect. |

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| **UNIT-IV (Nanotechnology)** | |
| **SHORT ANSWER QUESTIONS** | |
| 1 | Define NANOMETER and NANOSCALE. |
| 2 | What is quantum confinement? |
| 3 | Write about the relation between surface to volume ratio and the radius of the material. |
| 4 | When the radius of a sphere is doubled what happens to surface to volume ratio? |
| 5 | If the radius of the sphere is 6nm, then find out the surface to volume ratio. |
| 6 | What will happen to the surface to volume ratio of the cylinder if the radius is tripled and its height is halved? |
| 7 | What are the basic approaches used to prepare nanomaterials? |
| 8 | What is top- down approach? Give some example methods. |
| 9 | Write briefly about bottom-up method of synthesis of nanomaterials. |
| 10 | List the advantages and disadvantages of PVD process. |
| 11 | What are the major drawbacks of Ball milling technique? |
| 12 | Differentiate top-down and bottom-up methods |
| 13 | What is mean by Characterization of the material? List any two material characterization techniques? |
| 14 | What is the main difference between SEM and TEM? |

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| 15 | What is the importance of Bragg's law in XRD characterization? |
| 16 | Write the advantages of XRD technique in the material characterization |
| 17 | Write the advantages of SEM. |
| 18 | What are the drawbacks of TEM? |
| 19 | What are the applications of CVD. |
| 20 | Write some applications of nanotechnology. |
| | **LONG ANSWER QUESTIONS** |
| 1 | Why [surface area/volume] ratio is very large for nanoparticles compared to bulk materials? Highlight any two examples associated with increase in surface area |
| 2 | What is the impact of quantum confinement on the nanomaterials? Explain with some examples |
| 3 | Explain bottom up & top-down approaches in nanotechnology. |
| 4 | Explain synthesis of nanomaterials by using Ball milling method. |
| 5 | Explain SOL-GEL synthesis for producing nanomaterials? Explain with the help of a neat sketch. |
| 6 | Explain CVD technique for producing nanomaterials with the help of a neat diagram? |
| 7 | Describe briefly about preparation of nanomaterials by using physical vapor deposition (PVD) method |
| 8 | Explain in detail how XRD analysis is important in nanomaterial characterization. |
| 9 | Explain the principle of TEM analysis of nanomaterials. |
| 10 | How is SEM used for nanomaterial characterization? |

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| | **UNIT-V (Lasers and Fiber Optics)** |
| | **SHORT ANSWER QUESTIONS** |
| 1 | Write the characteristics of laser. |
| 2 | Define spontaneous emission and stimulated emission of radiation. |
| 3 | Define population inversion. |
| 4 | Write various methods to achieve population inversion. |
| 5 | List out some applications of laser. |
| 6 | What are the important components of lasers? |
| 7 | What are the necessary conditions for lasing action? |
| 8 | Write relations between Einstein's coefficients |
| 9 | Energy gap of the semiconductor is 3eV, find out the wavelength of emitted photon. |
| 10 | A semiconductor diode laser has a peak emission wavelength of 1.55μm. Find its band gap. |
| 11 | What is the principle behind the functioning of an optical fiber? |
| 12 | Mention the applications of optical fibers. |
| 13 | Define acceptance angle of an optical fiber and write an expression for acceptance angle |
| 14 | Draw the structure of optical fiber. |
| 15 | Define numerical aperture of an optical fiber and also write the equation for Numerical aperture |
| 16 | Write the relation between numerical aperture and acceptance angle |
| 17 | Write the advantages of optical fibers over the conventional coaxial cables in communication |

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| 18 | Draw the refractive index profile of step index and graded index optical fibers. |
| 19 | Calculate the acceptance angle of a given optical fiber, if the Numerical aperture of the fiber is 0.41 |
| 20 | For an optical fiber, fractional index change is 0.14 and refractive index of cladding is 1.3. calculate refractive index of core |
| **LONG ANSWER QUESTIONS** | |
| 1 | Obtain the relation between Einstein's coefficients |
| 2 | a) Differentiate spontaneous and stimulated emission of radiation.<br>b) Explain briefly about the characteristics of laser |
| 3 | With a neat diagram, describe the construction and working of Ruby laser. |
| 4 | Explain the construction and working of He – Ne laser. |
| 5 | With the help of neat diagram, describe the construction and working of a semiconductor laser. |
| 6 | a) Explain the components which are used to produce the laser.<br>b) Write some important applications of lasers. |
| 7 | Derive an expression for the numerical aperture of optical fibers. |
| 8 | a) Differentiate the multimode step index and multimode graded index fibers.<br>b) Calculate the numerical aperture and acceptance angle of an optical fiber with core and cladding refractive indices being 1.48 and 1.45 respectively. |
| 9 | a) Explain the optical fiber communication system with the help of block diagram<br>b) Discuss various advantages of optical fibers in communication over the conventional ones |
| 10 | Describe the different types of fibers by giving the refractive index profiles and propagation details. |