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QUESTION BANK (DESCRIPTIVE)

Subject with Code: APPLIED PHYICS (19HS0849) **Course & Branch**: I-B.Tech – IISem - EEE. **Regulation:**R19

UNIT – I

Harmonic Oscillators

1. a) Define simple harmonic motion. Give three examples. (4M)
   b) Derive the equation of motion of simple harmonic oscillator and find its solution. (8M)
2. a) What is a simple harmonic oscillator? Derive the equation of motion of simple harmonic oscillator. (8M)
   b) A particle executes SHM with a period of 0.002 sec and amplitude of 10 cm. Find its acceleration when it is 4 cm away from its mean position and also obtain its maximum velocity. (4M)
3. a) Define simple harmonic motion and simple harmonic oscillator. Give examples. (4M)
   b) Write the properties of simple harmonic motion. (4M)
   c) A particle executing S.H.M is represented by $x=10\sin(4\pi t+\pi/3)$ m. Find the frequency and the displacement after a time of 1 second. (4M)
4. a) Define damped harmonic motion. Give examples. (4M)
   b) Derive and solve differential equation of damped harmonic oscillator. (8M)
5. a) Distinguish between damped and forced oscillations. (4M)
   b) Solve the differential equation of damped harmonic oscillator. (8M)
6. a) Explain logarithmic decrement, relaxation time and quality factor of an oscillator. (9M)
   b) The amplitude of a second pendulum falls to one half of its initial value in 150 seconds. Calculate the Q factor. (3M)
7. a) Explain different types of damped oscillations with suitable examples. (8M)
   b) A point performs damped oscillations according to the law $x=a_o e^{-bt} \sin \omega t$. Findthe amplitude of oscillation andvelocity of the particle at the moment t=0. (4M)
6. a) What are damped oscillations? Solve the differential equation of a damped harmonic oscillator. (8M)
   b) Discuss the case of under damped motion. (4M)
9. a) What are forced oscillations? Give examples. (4M)
   b) Distinguish between damped and forced oscillations. (4M)
   c) Explain the phenomenon of resonance with suitable examples. (4M)
10. a) Distinguish between damped and forced oscillations with suitable examples. (4M)

b) Explain the phenomenon of resonance and write the applications of resonance in various fields. (4M)

c) The frequency of a tuning fork is 300Hz. If its quality factor Q is $5x10^4$, find the time After which its energy becomes (1/10) of its initial value. (4M)

UNIT – II

Principles of Quantum Mechanics

1. a) What are matter waves? Write their properties. (4M)
   b) Derive the expression for de Broglie wavelength. (4M)
   c) Calculate the velocity and kinetic energy of an electron of wavelength $1.66x10^{-10}$m. (4M)
2. a) Explain de Broglie hypothesis. (4M)
   b) Calculate the de Broglie wavelength associated with a proton moving with a velocity of 1/10 th of velocity of light. (4M)
   c) Illustrate Heisenberg uncertainty principle and write its significance. (4M)
3. a) Explain the concept of matter waves. (2M)
   b) Prove that the product of uncertainty of pair of variables describing the motion of particles is always not less than $h/4\pi$. (4M)
   c) Deduce Schrodinger time independent wave equation. (6M)
4. a) Derive the expression for de Broglie wavelength of matter waves. (4M)
   b) Obtain an expression for wavelength of electron accelerated in a potential V. (4M)
   c) Calculate the wavelength associated with an electron raised to a potential of 1600 V. (4M)
5. a) Derive Schrodinger time independent and time dependent wave equations. (12M)
6. a) Deduce Schrodinger time independent wave equation. (8M)
   b) Write the physical significance of wave function ψ. (4M)
7. a) Deduce Schrodinger time dependent wave equation. (8M)
   b) Write the physical significance of wave function ψ. (4M)
8. a) Write the Schrodinger time independent wave equation. (2M)
   b) Discuss the solution of stationary state Schrodinger equation for particle in a box. (10M)
9. a) Outline the behavior of particle in a one dimensional potential box in terms of eigen values and eigen functions. (8M)
   b) An electron is confined to a one dimensional box of width 2 A, then calculate the energies corresponding to the second and fourth quantum states. (4M)
10. a) Deduce the solution of Schrodinger wave equation for particle confined in a box. (8M)
    b) An electron is confined in a one dimensional potential box having width of $3x10^{-10}$ m. Estimate the kinetic energy of electron when it is in the ground state. (4M)

Unit – III

Electron Theory of Metals & Semiconductors

1. a) What are the salient features of classical free electron theory? Derive an expression for electrical conductivity in a metal. Mention its drawbacks. (8M)
   b)Find relaxation time of conduction electron in metal if its resistivity is 1.54x10-8Ω-m and it has $5.8x10^{28}$ conduction electron/m^3. Given m= 9.1 x 10^{-31} kg, e= 1.6 x10^{-19} C. (4M)
2. a) Describe the quantum free electron theory of metals. (8M)
   b) Write the advantages of quantum freeelectron theory overclassical free electron theory. (4M)
3. a) Write the Fermi-Dirac distribution function. (4M)
   b) Explain the effect of temperature on Fermi-Dirac distribution. (4M)
   c) Evaluate the Fermi function for an energy KT above Fermions. (4M)
4. a) Write a note on sources of electrical resistance. (6M)
   b) Describe the origin of energy bands in solids. (6M)
5. a) Explain the formation of energy bands in solids with neat diagram. (6M)
   b) Classify the materials into conductors, semiconductors and insulators based on band theory. (6M)
6. a) What are intrinsic semiconductors? Deduce an expression for the carrier concentration and conductivity of intrinsic semiconductors. (8M)
   b)The following data are given for an intrinsic Ge at 300K. Calculate the conductivity and resistivity of the sample?
   (n_i= 2.4 x$10^{-19}m^{-3}$, μ_e = 0.39 $m^2V^{-1}S^{-1}$, μ_p = 0.19 $m^2V^{-1}S^{-1}$). (4M)
7. a) What are extrinsic semiconductors? Explain. (6M)
   b) Deduce an expression for the carrier concentration of extrinsic semiconductors. (6M)
8. a)What are direct and indirect band gap semiconductors? Give examples. (6M)
   b) Obtain an expression for life time of charge carriers in excited states. (6M)
9. a) Explain the diffusion and drift processes in a semiconductor. (8M)
   b) Obtain the Einstein's relations. (4M)
10. a) What is Hall Effect? Obtain an expression for Hall coefficient. Write the applications of Hall Effect. (8M)
    b)The R_H of a specimen is $3.66x10^{-4}$ m^3c^{-1}. Its resistivity is $8.93x10^{-3}$ohm-m.
    Find 'μ' and 'n'. (4M)

Unit – IV

Lasers and Fiber Optics

1. a) Write the characteristics of Lasers. (6M)
   b) Distinguish the spontaneous and stimulated emission of radiation. (6M)
2. a) Obtain the relationship between various Einstein coefficients of absorption and emission of radiation. (6M)
   b) Explain the condition for population inversion. (6M)
3. a) Explain the pumping mechanisms to achieve population inversion. (4M)
   b) Explain the construction and working of He-Ne laser with a neat diagram. (8M)
4. a) Explain the construction and working of Nd:YAG laser with a neat diagram. (8M)
   b) Write any four applications of lasers. (4M)
5. a) Explain the construction and working of He-Ne laser with a neat diagram. (8M)
   b) Explain in detail the applications of lasers in industry and medicine. (4M)
6. a) Describe the construction of optical fiber. (4M)
   b) Explain critical angle of incidence and total internal reflection with neat diagrams. (4M)
   c) Draw the block diagram of optical fiber communication system. (4M)
7. a) Deduce expressions for acceptance angle and numerical aperture of anoptical fiber. (8M)
   b) An optical fiber has a core material of refractive index 1.55 and cladding with refractive index 1.50. Calculate its numerical aperture. (4M)
8. a) Differentiate step index and graded index fibers. (8M)
   b) An optical fibre has a core refractive index of 1.44 and cladding refractive index of 1.40.Find itsθ_a. (4M)
9. a) Classify the optical fibers based on their refractive index profile. (6M)
   b) Explain the propagation of electromagnetic wave through optical fibers. (6M)
10. a) Outline the optical fiber communication system. (6M)
    b) Write any four applications of optical fibers. (6M)

Unit-V

(Physics of Nanomaterials)

1. a) Define Nano science and nanotechnology. (2M)
   b) Explain the basic principles of nanomaterials. (10M)
2. a) Describe the classification of nanomaterials with suitable examples. (4M)
   b) Nanomaterials behave differently in their properties than the bulk materials. Justify. (8M)
3. a) What are nanomaterials? Explain their classification. (3M)
   b) Explain in detail the quantum confinement effect and how it affects the optical and magnetic properties of nanomaterials. (5M)
   c) Write any two applications of nanomaterials in detail. (4M)
4. a) What are nanomaterials? Explain the basic principles of nanomaterials. (8M)
   b) Outline the properties of nanomaterials that are affected due to increased surface area to volume ratio. (4M)
5. a) Explain the synthesis of nanomaterials by ball milling method. (8M)
   b) Discuss the advantages of nanomaterials. (4M)
6. a) Describe the sol-gel method of synthesis of nanomaterials. (8M)
   b) Explain how the physical and optical properties changes when a material is brought down to Nano scale. (4M)
7. a) Describe any one method of fabrication of nanomaterials. (8M)
   b) Write any four applications of nanomaterials. (4M)
8. a) Discuss the advantages of nanomaterials in science and technology. (2M)
   b) Write a note on the properties of nanomaterials. (6M)
   c) Explain how nanomaterials are used in the field of medicine and sensor technology. (4M)
9. a) Explain the principle of Scanning Electron Microscopy (SEM). (8M)
   b) Write any two applications of SEM. (4M)
10. a) What is Scanning Electron Microscope? Discuss in detail the construction and working of SEM. (8M)
    b) Explain the strengths and limitations of SEM. (4M)