QUESTION BANK

Laser system and its applications (NOE-043)

Unit-I

Q.1: what is Compton Effect? Derive expression for Compton Shift.

Q.2: What is de-Broglie hypothesis? Describe the Davission and Germer experiment to prove that material particles posses wave characteristics.

Q.3: Distinguish between the phase velocity and group velocity. Show that the group velocity is equal to the velocity of particle.

Q.4: Explain Heisenberg's uncertainty principle and discuss its important applications.

Q.5: What is the physical interpretation of the wave function? How a free particle wave function signifies a particle in space and momentum?

Q.6: Derive both the time independent and time dependent Schrödinger equation for a non-relativistic particle.

Q.7: Discuss the result of one-dimensional box.

Q.8: An electron is confined to a one dimensional box of side 1A0. Obtain the first four eigen values of the electron in eV.

Q.9: Show that the phase velocity of a matter wave is c2/v, where c is the speed of light and v is the velocity of the particle.

Q.10: The wavelength of yellow spectral emission line of sodium is 5893A. At what kinetic energy would an electron have that wavelength as its de Broglie wavelength?

Q.11: If you double the kinetic energy of a particle, how does its de Broglie wavelength change? (b) What if you double the speed of the particle?

Q.12: Write down the Schrodinger's equation in the different regions of a finite potential well. State the boundary conditions that the wave function must satisfy.

Q.13: What accelerating voltage would be required for the electrons of an electron microscope if the microscope is to have the same resolving power as could be obtained using 100 keV gamma rays?

Q.14: Derive the Planck's radiation formula and show that the Rayleigh-Jeans law can be obtained from it as a limiting form.

Q.15: Obtain Wien's displacement law using the Planck's radiation formula.
Show that the total energy density for a black-body radiation is proportional to T^4.

Q.16: Derive the Compton effect equation: . ()'1cos*ehmc*λλθ−=−
A monochromatic X-ray beam, whose wavelength is 0.558 Å, is scattered off an electron through scattering angle of 460. Find the wavelength of the scattered beam and the kinetic energy of the recoil electron.

Q.17: (a) Obtain E & t uncertainty relation using x & px uncertainty relation.

(b) Obtain L & ϕ uncertainty relation from x & px uncertainty relation.
(c) What is the role played by the uncertainty principle in understanding of the (i) benzene molecule structure, (ii) peptide linkages in proteins and (iii) absence of electrons in nuclei.
(d) Explain the stability of matter as a consequence of the uncertainty principle.
(e) Yukawa suggested the existence of a massive meson to explain nuclear forces. Using the uncertainty relation, obtain a relation between range of force and the mass of meson.

Q.18: Discuss the conditions on differential equation to be satisfied by the function ψ(x,t) describing a particle. Also explain the process of construction of the Schrodinger equation for a particle (I) in free space and (ii) in a potential field V(x). State the assumptions involved in the development of quantum mechanics.

Q.19: Write the Schrodinger's time dependent equation for a particle in a potential field V(x) and convert it to its time independent form. State the assumptions involved. Why is the eigenvalue associated with the time part of the equation, considered real?

Unit-II

Q.1: Explain the terms absorption, spontaneous emission and stimulated emission of radiation. Obtain a relation between transition probabilities of spontaneous and stimulated emission.

Q.2: What do you mean by population inversion in connection with 'LASER'.

Q.3: What are the main components of a LASER?

Q.4: Write two important characteristics of a Laser beam.

Q.5: What do mean by optical cavity?

Q.6: .Define the terms: i) Stimulated absorption
ii) Spontaneous emission
iii) Stimulated emission

iv) Pumping
v) Meta-stable state
vi) Population inversion
vii) Active medium.

Q.7: What do you mean by coefficient of gain? Find an expression for it.

Q.8: What do you mean by optical pumping?

Q.9: Calculate he coherence length of a Laser beam for which the band width = 3000 Hz. Speed of light = $3x10^8$ m/s

Q.10: Explain the terms: i) Stimulated absorption
ii) Population inversion
iii) Pumping

Unit-III

Q.1: Explain the principle of Laser action.

Q.2: Why is a four level Laser more efficient than a three level laser?

Q.3: What is an optical resonator?

Q.4: Draw schematic diagram of a febry-perot resonator.

Q.5: What do you mean by Q-switching?

Q.6: Draw schematic diagram of a four level laser.

Q.7: Define Q-factor of an optical resonator. Show that $Q = \nu_0/ \Delta\nu$, where ν_0 resonant frequency, and $\Delta\nu$ = full width at half maximum.

Q.8: What do you mean by the efficiency of a laser?

Unit-IV

Q.1: Describe the construction and working of a Ruby laser with necessary diagram.

Q.2: Describe the construction and working of a Nd-YAG laser with necessary diagram.

Q.3: Draw a neat diagram of He-Ne laser and describe its working. What are the characteristics of output laser beam from He-Ne laser?

Q.4: Draw a neat diagram of CO_2 laser and explain its working.
Q.5: Draw a neat diagram of Argon-ion laser and explain its working.

Q.6: Explain the construction and working of an Excimer laser.

Q.7: Why do you mean by a dye laser? Explain its working. Why does it produce ultra short pulses?

Q.8: Describe generation and measurement of short laser pulses. **Q.9:**

What do you mean by mode-locking?

Q.10: Explain the principle of a semiconductor laser.
Q.11: Explain the construction and operation of ruby laser with a neat diagram.

Q.12: Explain the construction and operation of gas laser with a neat diagram

Q.13: Explain the construction and working of semiconductor laser with neat diagram.

Unit-V

Q.1: What is holography? What is the use of laser in holography?

Q.2: What is the use of laser in metrology?

Q.3: Explain the process of hole drilling with lasers.

Q.4: Explain the process of cutting with lasers.

Q.5: Explain the process of lasers welding.

Q.6: Mention a few applications of laser in medical science.

Q.7: What are the components of optical communications? Why is modulation needed? Explain the types of modulation.

Q.8: Why is optical regarded as best channel for optical communication? Describe the types of optical fibers.

Q.9: What is LIDAR? How is the process achieved?

Q.10: Explain how laser is used in material processing and also explain laser heating process and laser trimming of material.

Q.11: What is the optical fiber, on what principle is it based?

Q.12: Define Holography and explain recording and reconstruction of a hologram.

Q.13: List the use of holography.

Q.14: . Explain about any three scientific applications of holography.

Q.15: Describe the construction and reconstruction of hologram.

Q.16: Explain about laser interaction with tissue.

Q.17: Mention the advantages of laser surgery and photothermal application.

Q.18: . Explain about laser endoscope and explain about endoscope laser coagulation.

Q.19: List and explain how lasers are used in nonlinear optics for basic sciences.

Q.20: List all the applications of laser.

Q.21: .Describe any four medical applications of laser in detail.