UNIT – I
QUANTUM MECHANICS (Theory Questions)

- QUANTUM NATURE OF RADIATION/ PLANCK’S QUANTUM HYPOTHESIS
  (a) State Planck’s quantum hypothesis. Why is it considered as radical departure from classical theory?
  (b) How quantum mechanics is different from classical mechanics.
  (c) Define photon and mention its properties.
  (d) Name any four physical phenomenon’s, which could not be explained on the basis of Classical theory.

COMPTON EFFECT
1. Explain what you understand by Compton Effect. How the wave theory of light fails to explain it?
2. Explain Compton Effect on the basis of quantum theory. Why did the classical theory fails to explain the Compton effect
   (SK8) (6)
   (SK2) (3) (W2000,WK4) (SK4) (5)
4. Write down the equations of energy and momentum conservation in Compton effect
5. Why there is no change in wavelength for a photon striking a bound electron?
6. What is Compton effect? Write expression for Compton shift? And explain the existence of modified component in
   Compton effect (SK9) (6)
7. Write expression for Compton shift? And explain the existence of modified component in Compton effect (SK9) W-2014
   (SK2) (3) (W2000,WK4) (SK4) (5)
8. What is Compton shift? Mention clearly the assumptions made as well as discuss its limitations.
9. Discuss Compton effect. On the basis of quantum theory, explain in brief, the existence of modified component in
   Compton scattering. (SK6,old)(4) (SK7,old) (5)
10. Explain in brief Compton effect on basis of quantum hypothesis. (SK5) (4)
11. (a) Explain how it confirms the photon nature of radiation?
    (b) Why is it impossible for a free electron to completely absorb photon?
12. How Compton Effect arise due to the action of photons on electrons. Explain how linear momentum is conserved in
    Compton Effect.
13. According to special theory of relativity , the effective mass of the particle moving with large velocity is 
    \[ m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \] 
    Show that energy (E) of the particle is equal to 
    \[ \sqrt{(m^2 v^2 c^2 + m_0^2 c^4)} \] 
    where letters have their usual meanings. (SK2) (5)
14. What is Compton effect? On the basis of quantum theory, explain the existence of modified component in Compton
    scattering.
15. Explain in brief Compton effect on basis of quantum hypothesis. (SK5) (4)
16. In Compton effect what happens
    (1) When photon collides with free electron in the scattering block? Write down the equations of energy and
        momentum conservation.
    (2) When photon collides with bound electron? (SK3) (9)
17. In Compton effect what happens:
    (1) When photon collides with free electron in the scattering block?
    (2) When photon collides with bound electron in the scattering block? (SK10) (4) (SK-13) (4)
18. In Compton effect when a photon collides with a bound electron its wavelength does not change. Give reason.

19. What is Compton effect? Why it is observed in light elements? Why Compton shift is not detectable for the visible range of light? (Summer-2011) (2+2+2)

20. In Compton effect, considering elastic collision between a photon and a free electron, write down equations of energy and momentum conservation. (SK-13) (3)

21. What is Compton effect? On the basis of quantum theory, explain the existence of modified and unmodified component in Compton scattering. (Sum-2014) (Sum-2015)

22. State characteristic of photon. (Sum-2014) (2)

23. Prove that free electron not absorbs the photon. W-2014

DE-BROGLIE HYPOTHESIS , DAVISSON AND GERMER EXPERIMENT

1. Describe Davisson and Germer experiment. What does it confirm? (SK7) (6)

2. Explain how the observations of Davisson and Germer’s experiment justify the wave nature of matter(WK9)(SK12) S-2015

3. Calculate the wavelengths of electron using (i) Bragg’s law and (ii) De-Broglie’s hypothesis using the data as obtained in the Davission Germer experiment. Explain the importance of results obtained. (SK6,new) (5)

4. Describe in detail, the experiment that provides the validity of De-Broglie’s hypothesis regarding the wave nature of matter. (SK6,old,WK4) (5)

5. Explain the concept of matter waves. How is the wave nature of electron demonstrated experimentally? Explain with the help of an experiment. ([WK6, old] (5)] (WK6,new) (8)

6. How could Dvisson and Germer be sure that peak obtained for 54 V electrons was a first order diffraction peak? (S2000) (3)

7. Give an account of Davission of Germer Experiment to show the wave like character of a beam of electron. W-2014

8. Explain deBroglie concept of matter waves. Give an account of Davisson and Germer experiment to show Wave like character of a beam of electrons (WK8) (6)

9. Explain concept of matter waves. Describe in brief an experiment to verify this.

10. Explain concept of matter waves. Illustrate with the help of Davisson and Germer experiment. (Sum-2014) (4)

11. What is deBroglie hypothesis? show that the De-Broglie wavelength for an electron accelerated by an electric field is 12.26/√V Å, where V is an accelerating voltage of an electron S-2015

12. What is deBroglie hypothesis? Write down the expression for wavelength associated with an electron accelerated through a potential of V volts. (SK9) (3)

13. Show how the quantization of angular momentu follows the concept of matter waves. (SK-13) (3)

14. Explain the concept of matter waves. Also show that the De-Broglie wavelength for an electron will be equal to 12.26/√V Å, where V is an accelerating voltage of an electron. (WK2,WK6,old) (5)

15. (a) Show that the de Broglie wavelength for an electron accelerated by an electric field of V volts/meter is

\[
\left(\frac{12.26}{\sqrt{V}}\right) \text{Å}. \quad \text{(SK12)} \quad (3)
\]

(b) Mention one important application of matter waves.

(c) Why the wave nature of matter is not apparent in our daily observations?

(d) Discuss the similarities and dissimilarities of matter waves with electromagnetic waves.

16. Discuss de Broglie’s concept of matter waves in light of the wave-particle dualism of radiation. (WK3) (4)

17. What are matter waves? Give in brief an experiment confirming wave nature of matter. (SK-13) (5)

BOHR’S QUANTIZATION CONDITION

1. Explain how de Broglie's hypothesis regarding wave nature of matter leads to Bohr's quantization condition for angular momentum of electron. (WK7) (4)

2. Show how the quantization of angular momentum follows the concept of matter waves. (SK-13) (3) (Sum-2014)

(Sum-2015)

3. How Bohr’s condition of stationery orbits of an atom can be obtained from the concept of matter wave? (WK2) (4)
UNIT – II
WAVE PACKET & WAVE EQUATIONS (Theory Questions)

- **WAVE PACKET**
  1. Explain why a single monochromatic wave can not represent a particle. (SK9) (3)
  2. Can a wave equation given by an equation \( Y=A \sin (\omega t-kx) \) represent a particle? Explain the concept of wave packet. How does this concept lead to Heisenberg’s uncertainty principle? (S2000) (6)
  3. Why does a single monochromatic wave not represent a localized particle? Explain synthesis of wave packet. (SK4) (5)
  4. Distinguish between phase velocity and group velocity. (SK10) (2)
  5. Define the terms: (i) Phase velocity (ii) Group velocity (iii) Wave packet. Show that group velocity is equal to the velocity of particle. (W2000) (4)
  6. Derive the relation between group velocity and phase velocity.
  7. Why does a single monochromatic wave not represent a localized particle? Explain synthesis of wave packet.
  8. Explain the terms: (i) Phase velocity (ii) Group velocity (SK-13) (2)
  9. What do you mean by phase velocity and group velocity? Obtain the relation between phase velocity and group velocity? (S-2015)
  10. Define i) phase velocity ii) group velocity? Obtain the relationship between phase velocity and group velocity. Give the significance of result. (S-2014) W-2014
  11. Show that the phase velocity of a de Broglie wave is greater than the velocity of light, but group velocity is equal to velocity of the particle with which wave is associated. W-2013

- **UNCERTAINTY PRINCIPLE**
  1. What is Heisenberg’s Uncertainty principle? Describe a thought experiment to arrive at this principle. S-2014
  2. What is Uncertainty principle? Is this principle the outcome of wave description of a particle? Describe diffraction of electron by single slit experiment to prove its validity. W-2013
  3. Write and explain Heisenberg’s uncertainty principle. Why it is significant only for subatomic particles and not for heavy bodies? (SK10) (Sum-2011) (4)
  4. What is Uncertainty principle? Discuss significance of it. (SK6,old) (2)
  5. State Heisenberg’s uncertainty principle. (W-2014)
  6. What is Heisenberg’s uncertainty principle? Explain how it is outcome of the wave description of a particle.(WK4)(4)
  7. Explain Heisenberg’s uncertainty principle and Give its applications (SK8) (4)
  8. Explain Heisenberg’s uncertainty principle using thought experiment. (SK-13) (4)
  9. Explain a thought experiment to arrive at Heisenberg’s Uncertainty Principle. (S-2015)
  10. Explain a thought experiment to arrive at Heisenberg’s uncertainty principle? (SK9) (SK12) (6)
  11. State and Explain Heisenberg’s uncertainty principle with the aid of a thought experiment.? (WK9) (4)
  12. State Heisenberg’s uncertainty principle and prove that electrons are not the constituents of nucleus. (WK8) (4)
  13. Discuss the significance of uncertainty principle. Describe thought experiment to show its validity.
  14. What is Heisenberg’s Uncertainty Principle? Explain the significance of this principle. Describe a thought experiment to arrive at this principle. (SK2,WK5) (7)
  15. Show how the concept of wave packet leads to the principle of uncertainty.
Uncertainty principle is a consequence of fundamental limitation imposed by nature. Justify.

The uncertainty in the location of a particle is equal to its de-Broglie wavelength. Show that the uncertainty in the velocity is equal to its velocity.

An electron is moving along X-axis passes through a narrow slit. It is observed to develop Y-component of velocity. Explain how it leads to Heisenberg’s Uncertainty principle?  

Show that uncertainty in the measurement of electron momentum is equal to its momentum itself; if the uncertainty in the measurement of location of electron is equal to de-Broglie’s wavelength.

In an atomic transition photon of frequency $(E_2 - E_1)/h$ is emitted. This emission pulse has duration $\Delta t$. Show from uncertainty principle that

$$\Delta \nu = \frac{1}{\Delta \nu}$$

State uncertainty principle. Write its mathematical form for the following pairs of variables:

(i) Position and momentum, (ii) Energy and time, (iii) Angular position and angular momentum.

SCHRODINGER’S WAVE EQUATION

1. What is wave function? When $\Psi$ is called well-behaved function. Explain.
2. State the properties of wave function $\Psi$.  (W-2013)
3. What is the physical significance of wavefunction $\Psi$?  

Using Schrödinger’s time dependent equation, Hence obtain Eigen values and Eigen function of a particle in an infinite potential well.

a) Show that the energy of micro particle confined in an infinite one dimensional potential well of length ‘$l$’ is given by,

$$E_n = \frac{n^2 h^2}{8mL^2}$$

where symbols have their usual meanings.

b) In the above situation, the particle can not have zero energy. Explain, why?

5. Show that the energy of electron confined in a 1-D potential well of length ‘$L$’ and infinite depth is quantized. Is the electron trapped in a potential well allowed to take zero energy? Why?

6. Write down: (i) Time independent and (ii) Time dependent Schrödinger equations.

Explain, why integral of $|\Psi|^2$ over all space must be unity.

7. What is physical significance of wave function $\Psi$? Why normalization of $\Psi$ is required?

8. Give the physical significance of wave function $\Psi$. Explain in brief mathematical conditions imposed on $\Psi$. (SK7)(2)

9. Write down Schrodinger’s time dependent and time independent wave equations for matter waves. Explain, why:

(i) Wave function $\Psi$ must be single valued and continuous function of position.

(ii) The integral of $|\Psi|^2$ over all space must equal unity.

10. Write down Schrodinger’s time independent wave equations for matter waves. Hence obtain the expression for eigen function ion of particle in one dimensional potential well of infinite height. (WK8)(6)

11. Write down Schrodinger’s time independent wave equations for matter waves. Hence obtain the expression for eigen function ion of particle in one dimensional potential well of infinite height. (WK8)(6)

12. Starting from Schrodinger’s time independent wave equation, show that the energy of a particle in one dimensional potential well of infinite height is quantized. Hence obtain the for eigenfunction for the particle. Show necessary waveform.

13. Explain using quantum theory why a particle will not exist in a box if its energy is zero.

14. Show that the wave function for particle confined in an infinite one-dimensional potential well of length 1 is given by $\Psi_n(x) = \sqrt{2/l} \sin(n\pi x/l)$ Hence, discuss the energy levels and their discreteness. (WK9) S-2014

15. Show that the wave function for particle confined in an infinite one-dimensional potential well of length l is given by $\Psi_n(x) = \sqrt{2/l} \sin(n\pi x/l)$. Hence using normalization condition on $\Psi$ show that $A$ is given by $\sqrt{2/L}$. (WK7)(8)

16. Show that energy of electron in one dimensional infinite potential well of width ’l’ is quantized. (SK6,old) (6)

17. Show that the solution of Schrodinger Equation for a particle in an infinite potential well leads to the concept of Quantization of energy.  

(W2000, WK6,old) (WK6,new) (8)
18. An electron is confined in a one dimensional potential well of infinite depth. Use Schrodinger’s wave equation to obtain energy states of an electron. Discuss how these results differ from classical one. (Sum-2011) (4+2)

19. An electron is confined in a one dimensional potential well of infinite depth. Use Schrodinger’s wave equation to obtain energy states of an electron. (SK12) (6)

20. Show that the wave function for particle confined in an infinite one-dimensional potential well of length $l$ is given by $E_n = \frac{n^2 \hbar^2}{8ml^2}$ where symbols have their usual meanings. Is the electron trapped in a potential well, allowed to take zero energy? Why? (S-2015)

21. A particle is confined in one dimensional potential well of infinite depth. Use Schrödinger’s wave equation to obtain energy states of a particle inside the well. (W-2014)

**Tunneling**

1. What is tunneling? How is it explain quantum mechanically.

2. Explain the tunneling effect. (SK10) (3)

   Explain in short the phenomenon of tunneling that occurs when a beam of particles are incident on potential barrier of finite width. (WK6,new) (SK6, new) (S-2015)

3. Explain the phenomenon of tunneling, when a beam of particles are incident on potential barrier of finite width. (Sum-2011) (3)

4. Discuss the phenomenon of leaking of a particle through a rectangular potential barrier of finite width. State one application of barrier tunneling. (SK-13) 3+1

5. Explain the phenomenon of tunneling, when a beam of particles are incident on potential barrier of finite width. S-2014
UNIT – III
CRYSTAL STRUCTURE (Theory)

1. Find the atomic radius, packing fraction and voids for SC and FCC unit cell [S/2012] (6)
2. Elaborate the statement, lattice + basis = Crystal structure. What is the smallest building block of this structure known as? [W/2003] (3)

3. Explain how to find number of atoms per unit cell for simple cubic, BCC and FCC structure in a crystal. Also find the relationship between atomic radius and inter atomic distance in each of these cases. [W/2002] (5)

4. For BCC and FCC lattices calculate:
   a. No. Of Atoms per unit cell.
   b. Atomic radius and

5. Obtain the relationship between lattice parameters and atomic radius for Simple Cubic, Body Centered Cubic and Face Centered Cubic lattices. Also obtain the values of Atomic packing fractions in each of these cases.[W/2005] (6)

6. Find atomic radius, packing fraction and void space for simple cubic crystal structure [W/2014]


8. Obtain the values of voids in case of FCC and BCC structures and also show that BCC has maximum voids

9. Show that the FCC structure is more closely packed than BCC structures. [S/2013] (4)

10. Show that FCC structure possesses maximum packing density among the three crystal structure SC, BCC and FCC [S/2015]


12. Show that the SC structure possesses a minimum percentage of packing density and maximum percentage of void space among all three cubic crystal structures.[S/02] (6)

13. Compare the unit cell properties of SC, BCC and FCC unit cell. [S/2001] (4)

14. Find the atomic radius, packing fraction and voids for SC and FCC unit cell.[S12](6)

15. Define packing fraction. Show that the packing fraction in FCC is more than that of BCC structure. [W/2008] (6)


17. Derive the relation between radius of atom and lattice constant in case of FCC and BCC structure. [S/2007-OLD] (4)

18. Derive the relation between atomic radius and cube edges in case of SC, BCC and FCC. [W/2007] (6)

19. Compute the atomic radius and packing fraction in case of BCC and FCC structure. [S/2011]

20. Define atomic radius and packing fraction. Calculate atomic radii and packing fractions for Body centered and face centered Cubic unit cell. [W/2013]

21. Calculate number of atoms per unit cell in Simple Cubic and Body Centered Cubic Unit cell. Show that atomic density of BCC is double than SC unit [W/2013]

22. What are tetrahedral and octahedral voids? [W/2006] (2)

23. The edge of the unit cell of cubic lattice is ‘a’. The atomic radius is ‘r’. For SC and FCC, find
24. Define:
   a. Space Lattice [W/2014] [S/2013]
   b. Unit Cell [W/2014] [S/2014] [S/2013]
   c. Co-ordination Number [S/2015] [W/2014]
   d. Packing density*
   e. Miller Indices. [S/2008] [S/2013]
   f. Packing fraction [S/2014]

25. Define:
   a. Space lattice
   b. Unit Cell
   c. Void space [S/2015]
   d. Co-ordination number [S/2010 ]

26. Explain
   i) Space lattice
   ii) Unit Cell
   iii) Miller indices [S/2013]

27. In a Cubic Lattice , Prove that
    \[
    d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}
    \]
    Where
    \( d_{hkl} \) is Inter planer distance,
    \( a \) is lattice constant and
    \( h, k, l \) are Miller Indices [S/2007] (4)

28. Deduce a relation between an inter planer distance \( d \) and the Miller indices of the planes for cubic crystal. [S/2010] [S/2012] [S/2013] [W/2014] (5)


30. Obtain an expression for inter planer spacing between two adjacent planes of Miller indices (hkl) in a cubic crystal. [ S/2015]

31. Derive the relation between interplaner spacing , lattice constant and miller indices of the planes for the cubic crystals. [S/2014]


33. Explain with an example the different steps to be followed, to identify the Miller Indices of a Crystallographic plane. [S/2007-OLD]

34. Deduce a Bragg’s condition for observing X-ray diffraction from a crystal and state its application. [S/2011] (3+1)

35. Explain and deduce Bragg’s law for X-ray diffraction [W-08, SK-13] (4)

36. Derive the Bragg’s law for X-ray diffraction in crystals. State any one application of it. [W/2013]

37. Derive and explain Bragg’s relation. How is it useful in crystal structure determination? Why is this law not useful for amorphous solids? Why X-rays are preferred to visible light in crystal structure determination? [W/2002] (5)

38. Obtain an expression relating the wavelength of the X-rays to the angular positions of the scattered beams and the separation of atomic planes in the crystal.

Can a natural crystal be used to diffract light rays? If not, why? [S/2000] (6)
UNIT – IV
SEMICONDUCTOR PHYSICS (Theory)

- BAND THEORY OF SOLIDS

1. Explain the formation of energy bands in solids on the basis of band theory. (4) S/K7
2. Draw a neat sketch of a band diagram of intrinsic semiconductor at room temperature and show that Fermi level in an intrinsic semiconductor lies in the middle of the energy gap. (5) S/K7
3. Draw the energy band diagram for the p-n junction diode in unbiased and Forward biased mode. (4) S/K7
4. According to band theory, a completely filled band or empty band is not associated with electric conduction. Only partially filled band is responsible for electrical conduction. Explain why. (4) S/K7/(Old)
5. If effective mass of an electron is equal to twice the effective mass of hole, determine the position of the Fermi level in an intrinsic semiconductor from the centre of forbidden gap at room temperature. (6) S/K7/(Old)
6. With a neat labeled diagram, explain transistor action, when it is biased to operate in the active region. Draw energy band diagram of N-P-N transistor common base mode. (6) S/K6
7. Explain the concept of hole. (2) S/K6
8. Explain drift current and diffusion current (3) SUM-14, WIN-15
9. (a) Draw a neat energy band diagram for n-type semiconductor at 0 K and T K. Explain the effect of high doping concentration on the Fermi level. (5) S/K6/(Old)
10. Explain in brief the concept of Fermi level. Derive an expression for Fermi energy in intrinsic semiconductor. What is the effect of temperature on Fermi level in intrinsic semiconductor? (4) S-15
11. What is Hall Effect? State two of its applications. (4) S/K6
12. Write the short note on and Three:-
   a) Classification of solids on the basis of energy bands. b) Transistor action c) Depletion region injection diode. d) Fermi function and its variation with Temperature. (9) S/K7
13. Draw the energy band diagram for the p-n junction diode in equilibrium, and hence obtain an expression for height of potential energy barrier $V_0$. (8) W/K6, S-2009 (5)
14. Obtain an expression for the contact potential ($V_0$) for P-N junction in equilibrium. (SK-13) (4)
15. A light emitting diode uses a p-n junction of silicon (energy gap = 1.1 eV): i) What minimum potential difference must be applied to the junction to cause it to emit light? ii) To which side of the junction the p or n-side must the positive terminal of the battery be connected? (2) W/K6
16. Explain Hall Effect and obtain an expression for Hall Coefficient for an extrinsic semiconductor. (6) Sum-2011, SUM-2012, (4) WIN-14
17. What is Hall Effect? Derive an expression for Hall voltage and co-efficient for an extrinsic semiconductor. (5) SUM-15
18. Explain the induction of hall voltage in a semiconductor carrying current and placed in transverse magnetic field. also obtain an expression oh hall coefficient (4) SUM-14
20. Explain the formation of a depletion region in a pn junction. Also, draw its well diagram under equilibrium condition. (6) W/K6 (Old), Sum-2012
21. Explain the formation of a depletion region in a pn junction Diode. (4) WIN-14
22. Obtain an expression for the contact potential ($V_0$) for P-N Junction in equilibrium. (4) SUM 2013, SUM 2015
23. Assuming suitable equations, derive the expression,
\[ V_o = \frac{kT}{e} \ln \frac{N_D N_A}{n_i^2} \] for pn junction. \hspace{2cm} (4) W/K6/(New)

24. Draw a neat energy band diagram for pnp transistor when (i) unbiased and (ii) biased in common base mode. \hspace{2cm} (3) S/K5, Sum-12

25. Draw a neat energy band diagram for npn transistor when biased in common base configuration. \hspace{2cm} (2) SUM 2013

26. Draw energy band diagram for N-type semiconductor at 0\(^\circ\)K and T\(^\circ\)K. \hspace{2cm} (3)WIN-14

27. Draw a neat energy band diagram for P-N-P transistor when biased in common base mode and in unbiased mode. \hspace{2cm} (3) WIN-14

28. Draw neat energy band diagram for symmetrically doped PN Junction diode. When it is:
   i) Un-biased
   ii) Forward biased \hspace{2cm} (3) Sum-14

29. Draw a neat energy band diagram for npn transistor
   (i) unbiased and
   (ii) biased in common base mode. Showing various currents \hspace{2cm} (5)S/2010

30. Explain the formation of potential barrier across the junction region of semiconductor diode. \hspace{2cm} (3) S/K5

31. Explain Hall Effect and its importance. \hspace{2cm} (4) S/K5

32. Write down Fermi distribution function \( f(E) \). Show graphically and analytically that \( f(E) \) as function of \( E \) always passes through a point \( \left( E_F = \frac{1}{2} \right) \) at different temperatures. \hspace{2cm} (4) S/K5

33. What is meant by Fermi distribution function? Define Fermi level. \hspace{2cm} (3) SUM -2013

34. Draw energy band diagram for (i) intrinsic semiconductor (ii) n-type semiconductor (iii) p-type semiconductor at 0 K and room temperature. \hspace{2cm} (4) S/Ksand S/K4

35. What is Fermi function? Draw graph showing its variation with energy at different temperature and show that the Fermi function is symmetrical at \( E=E_F \). \hspace{2cm} (2+4) S/K4, S/2011

36. What is Fermi Dirac distribution function? Show that Fermi energy level lies midway between conduction band and valence band in intrinsic semiconductor. \hspace{2cm} (4) SUM-14

37. Draw the energy band diagram for the p-n junction diode under the following conditions:
   (i) Unbiased (ii) Forward biased and (ii) Reversed biased. \hspace{2cm} (6)W/k4& S/K3

38. Why are holes not generated in Metals? Can the electric conductivity of metal be altered to the extent possible in a semiconductor? Discuss? \hspace{2cm} (3)W/K4

40. What is Hall Effect? Derive the formula for density of charge carriers in a p-type semiconductor. \hspace{2cm} (6) (3)W/K4

41. Explain why in a transistor : (i) Base is thin and lightly doped (ii) Collector region has larger area of cross section. \hspace{2cm} (3)W/K4

42. Explain in brief the concept of Fermi level, Derive an expression for Fermi energy in intrinsic semiconductor. \hspace{2cm} What is the effect of temperature on Fermi level in an intrinsic semiconductor? (3)S/K3

43. Differentiate between drift and diffusion currents. \hspace{2cm} (2) S/K3

44. Explain the terms:
   Drift Current
   Diffusion Current. \hspace{2cm} (2) Sum-2011

45. Explain why we have energy bands in solid but energy levels in gases. Draw a typical band diagram. In this diagram show an electron which is (i) free (ii) bound (iii) very close to the nucleus. \hspace{2cm} (5) W/K3

46. Difference between an intrinsic and in n-type semiconductor on the basis of (i) crystal representation, (ii)band representation and (iii) relation between \( n \) and \( p \). \hspace{2cm} (5) W/K3

47. Explain Hall effect and give two of its application. \hspace{2cm} (4) S/K2

48. Show that the occupancy probabilities of two states whose energies are equally spaced above and below the Fermi energy add up to one. \hspace{2cm} (3) S/K0

49. Show that at 0 K the Fermi level lies midway between the donor level and the bottom of conduction band for n-type material with high doping concentration and low temperature. \hspace{2cm} (6) W/K0
50. Draw energy band diagram for a p-n junction diode in equilibrium. Show that the height of potential barrier is

\[ eV_0 = kT \log \left( \frac{N_D N_A}{n^2_i} \right) \]

given by:

where, symbols have their usual meaning. (6) W/K0

51. What is law of mass action? (2) S/2010

52. Derive the rectifier equation for P-N junction diode. (6) S/2010

53. Explain the formation of depletion region in a p-n junction diode. (3) Sum/2011

54. Explain forward and reverse bias characteristics of zener diode (4) SUM-2013

55. Explain V-I Characteristics of Zener diode. (2) SUM-15
1. Explain how four level pumping scheme is more efficient than three level pumping scheme. [Summer 2012] (3)
2. Explain the function of Optical resonant cavity. [Summer 2012] (4)
3. Explain construction and working of He-Ne laser with the help of energy level diagram. [Summer 2012] (6)
4. With the help of neat sketches, explain the three quantum processes that may occur when light radiation interacts with matter. Which of these processes is maximized in Laser operation? (SK7, SK6(old), WK3(5)) (6)
5. With the help of neat sketches, explain the three quantum processes that may occur when light radiation interacts with matter. Which of these processes is maximized in Laser operation? What are necessary conditions for their occurrence? Why does spontaneous emission dominate over stimulated emission at normal temperature? (WK2) (5)
6. How can you experimentally distinguish between coherent and non-coherent light? (WK2) (3)
7. Explain the terms: Spontaneous and Stimulated emission. Which of the two emission processes is maximized in LASER operation? How? (WK4) (6)
8. Explain with a neat diagram Spontaneous and Stimulated emission of radiation. [W12] (3)
9. (a) What is LASER? How it differs from an ordinary source of light? Mention any three engineering applications of laser. (SK5) (5)
   (b) Discuss the properties/characteristics of LASER beam. (S2000) (S2011) (5) (3)
10. Explain in brief following characteristics of Laser:
   (i) Coherence and
   (ii) Intensity (WK4) (3)
11. Explain the term coherence length and coherence time? Derive the expression for the coherence length of a wave in terms of the line width \( \Delta \lambda \) corresponding to frequency band \( \Delta \nu \).
   Or Explain the measuring of temporal coherence and explain how duration of single wave train or the length of single wave train can be a measure of temporal coherence.
12. Explain the terms: Stimulated emission, Population inversion, Pumping and Metastable states. W-2014 (3)
13. Distinguish between (i) Spontaneous and stimulated emission.
   (ii) Three level and four level lasers. (SK6) (6)
14. (a) What do you understand by negative temperature state? How can it be achieved?
   (b) What are different mechanisms of pumping?
15. Explain the terms (any three):
   (i) Stimulated emission (ii) Metastable State (iii) Optical Pumping (iv) Population inversion (WK6) (6)
16. Explain in LASER:
   i) Why active media should have preferably broad absorption band? (WK4) (2)
17. Explain the terms (any three):
   (i) Stimulated emission (ii) Metastable State (iv) Population inversion (iv) Temporal and spatial coherence (SK2(4), SK4) (3) [S-2013] (3)
18. Explain the terms (any three)
   Spontaneous emission (ii) Stimulated emission (iii) Population Inversion W-2016
19. Explain the terms:
20. Explain the terms
   i) Spontaneous emission ii) Metastable state iii) Pumping
State the role of each of the above in the working of laser. (SK9) (6)

21. Define the terms:
   i) Metastable state ii) Temporal coherence iii) Stimulated emission

22. What is population inversion? How it is achieved by optical pumping? (W2000) (3)
23. What is population inversion? Why it is necessary for lasing? (W2012) (3)
24. Explain in brief (i) Temporal and (ii) Spatial coherence. (W2000, SK1) (4)
25. Explain in brief three and four level pumping schemes. Why four level scheme is preferred over three level scheme? (SK7, old) (5)

26. Explain in brief how four level laser is more efficient than three level laser. (SK5) S-2015 (4)

27. Why a four level laser is more efficient than three level laser? (WK3), W-2013 (3)
28. State and explain, the two important pumping schemes in Laser. (SK3) (4)

29. (a) What is resonant cavity? Explain in short its importance in producing laser beam with neat sketches. (WK6(old), SK6(old,3), WK5) (4)
   (b) Explain how monochromaticity is obtained in Laser? (W2000) (3)
   (c) What is role of resonant cavity length in supporting different frequency modes? (SK3) (4)

30. Explain the lasing action based on cavity resonator. (SK4) (5)
31. Explain the construction and working of optical resonant cavity. (W-2015)
32. (a) Describe the construction and working of a solid state Ruby laser.
    (b) Describe the action of ruby laser using energy level diagram.
    (c) Why the end faces of the ruby rod are silvered? (SK7, SK7(old)) (4)
33. Explain the principle and working of Ruby Laser. (SK4) (6), (WK-12) (4)
34. Explain the construction and working of a solid state Ruby laser. W-2016
35. Explain with the help of neat energy level diagram, how stimulated emission results from electron impact pumping in He-Ne gas laser? (SK1) (6)
36. (a) Explain the construction working and action of Helium-Neon laser. (W2014), (SK5) (4)
    (b) Explain the role of end mirrors in laser. What frequencies are amplified by this mirror system? (SK9) (3), (WK6) (2)
    (c) What is the role of helium atoms in He-Ne laser? Or In He-Ne laser, emission is from Neon. Then what is the role of helium? Why it is necessary to use a tube of narrow diameter? (WK4, (2), WK6, old) (3)
37. What is the reason of monochromaticity of laser beam? Explain the working of He-Ne laser. Explain its engineering applications. (SK2) (6)
38. Explain the working of Ruby or He-Ne laser with the help of energy level diagram. (WK6, SK6, old) (4) WIN-13(5) S-2015
39. Explain working of Ruby laser or semiconductor diode laser. (SK3) (5)
40. Explain the construction, working and limitations of Ruby LASER of neat label diagram. [S-13](5)
41. Describe with the energy level diagram, the construction and working of He-Ne Laser. S-2016
42. Explain working of semiconductor diode laser. (S-2000) (5)
43. What is meant by population inversion and how is it achieved in ruby laser. (W-2015)
44. Draw well labeled energy level diagram for He-Ne laser. (W-2015)
45. Give the construction and working of semiconductor laser. Draw necessary energy level diagrams.
46. Give two engineering applications of laser source and discuss one of them.
Interference

1. What is the difference between optical and geometrical path difference? \( \text{W2K5 S2K1} \) (2)

2. Why is the concept of coherence of central importance in the study of interference? How is the interference pattern controlled by the temporal and spatial coherence of source? \( \text{W2K3} \) (4)

Thin Film

3. What do you mean by thin film? Deduce a condition of minima in case of a thin parallel film. \( \text{S2K7/old} \) (7)

4. Write down the expression for true optical path difference in interference due to reflected light in case of plane parallel thin film. \( \text{S2K9} \) (2)

5. What is a thin film? Obtain an expression for the path difference in case of interference in thin films due to reflected light. \( \text{S2K6/new, W2K8} \) (6)

6. Obtain conditions for maxima and minima due to interference of reflected light in thin film of uniform thickness. \( \text{W2K5} \) (5)

7. Explain the phenomenon of interference in thin film of uniform thickness due to reflected light. What happens when:
   a. Monochromatic light is incident normally on the uniform thin film?
   b. White light is incident on the film? \( \text{S2K3} \) (4)

8. Obtain condition for maxima and minima due to interference of reflected light in thin films of uniform thickness. Why the film should be thin. \( \text{W2K2} \) (6)

9. Derive an expression for path difference and conditions for constructive and destructive interference for phenomenon of interference in thin parallel film in reflected light. \( \text{W-2015} \)

Wedge Shaped Film

10. Obtain an expression for fringe width and wedge angle in wedge shaped thin film. \([\text{S12]}(4)\)

11. Obtain an expression for fringe width and wedge angle in wedge shaped thin film. Explain why the fringe at the apex is dark. \( \text{W-2016} \)

12. What is thin film and Obtain an expression for fringe width in interference pattern obtained in wedge shaped thin film. \([\text{W-2012} (5) \text{[W-2013]}(4) \text{S-2015}] \)

13. The calculated path difference in interference due to reflected light is given by \(2\mu t \cos \gamma\), where symbols have their usual significance. What types of fringes do we get if:
   a. \( t \) and \( \mu \) are constant and
   b. \( r \) and \( \mu \) are constant?

   Explain how former are different from latter. \( \text{S2K6/old, S2K} \) (5,4)

14. What is thin film? Derive the expression for the fringe width of interference pattern obtained in wedge shaped film. \( \text{Sum 2011(1+4) [S-2013]} (1+3) \)

15. A wedge shaped air film is illuminated from top by a monochromatic light, discuss the salient features exhibited by the interference pattern generated in the process. Assume the interference to be due to reflected light. \( \text{W2K6/old} \) (4)

16. Obtain an expression for fringe width in interference pattern obtained in wedge shaped thin film. How it is used for testing the optically flat/plane surface? \( \text{S2K4 (6) W2K, S2K8} \) (5)

17. Derive an expression for fringe width in interference pattern obtained in wedge shaped thin film. How this phenomenon is used for testing the optically flat surface? \( \text{(W-2014) (4)} \)

18. What is thin film? Obtain an expression for fringe width in the interference pattern of wedge shape thin film. How this phenomenon is used to determine the thickness of thin wire? \( \text{S2K2} \) (5)

19. Obtain an expression for fringe width in interference pattern obtained in a wedge shaped film. \( \text{S2K1} \) (3)

20. Obtain an expression for fringe width of interference pattern obtained in a wedge shaped film. Explain why the fringe at the apex of the wedge is always dark. \( \text{W2K9} \) (6)

21. Explain how phenomenon of interference can be used for testing the optical flatness of a surface. \( \text{S2K7/old} \) (2)

22. Explain how interference phenomenon can be used for:
   a. Testing the optical flatness of a surface
   b. Comparing the thickness of mechanical gauges. \( \text{S2K6/old, S2K} \) (4)

Newton’s Rings

23. Describe Newton’s rings experiment to determine wavelength of incident monochromatic light. \( \text{S2K7/ new} \) (5)

24. State any two applications of Newton’s Ring Experiment. In this experiment, why:
   1) rings are not evenly spaced?
   2) Central fringe is dark? \( \text{Sum-2011 (1+3)} \)

25. In Newton’s Ring experiment, why:
   a. The Plano convex lens should have larger radius of curvature?
   b. The rings get closer away from the center?
c. Central fringe is dark in reflected light?

26. In a Newton’s ring experiment, light of red color is used first and then a blue light. Which set of rings would have larger diameter and therefore greater spacing between them? S2K2 (4)

27. In Newton’s rings experiment, if observed in reflected light, is it possible to obtain bright spot at centre? Justify your answer. In Newton’s ring experiment, why are rings crowded away from centre? S2K1 (4)

28. How can Newton’s rings experiment be used to determine the refractive index of a liquid? W2K (4)

29. Why are circular fringes obtained in Newton’s rings arrangement? Why is the central spot dark as seen by reflection? Why are rings crowded away from the centre? S2K9 (2+1+2=5)

30. Why a Newton’s ring experiment the central spot is dark? W-2013

31. Draw a neat diagram of experimental set up for the Newton's rings formation. Why are the rings circular? Why the rings are not evenly spaced? S-2016

32. Draw appropriate diagrams illustrating the interference in thin films in the following cases. Label the interfering rays as ray 1 and 2, and write down expressions for the total path difference between them:

- a. Constant thickness film
- b. Wedge shaped film
- c. Film enclosed between a plano-convex lens and plane glass plate in Newton’s rings apparatus. W2K3 (6)

### Antireflection Coatings

33. What are antireflection coatings? Explain the principle and applications. [W-2012] (3)

34. What is antireflection coating? S2K4, S2K9 (2)

Obtain condition for minimum thickness of such a coating. Why do coated lenses look purple by reflected light? S2K3 (6)

35. What is antireflection coating? Why are lenses coated with thin film to improve transmission of light? (W-2014) (3)

36. What is antireflection coating? Obtain condition for minimum thickness of such a coating. W-2016, W-2013 (4)

37. What is antireflection coating? Obtain the condition of refractive index of coating material for zero reflectivity. W-2015

38. What is antireflection coating? Obtain the condition for minimum thickness of such a coating. S-16
UNIT – II : ELECTRON BALLISTICS (THEORY)

1. Discuss the motion of an electron projected into uniform electric field at an acute angle with the field direction. Obtain expressions for Range, time of flight and maximum height attained by the particle. [Summer 2012] (6)

2. Discuss the motion of charged particle when it enters transverse magnetic field. [S2012] (3)

3. In a transverse uniform magnetic field, show that the radius of the curvature of the path of charged particle is proportional to its momentum. [Summer-2013] (4)

4. Show that the radius of charged particle moving at an right angle to a magnetic field proportional to its momentum. [Summer-2013(New)] (4)

5. A charged particle of charge q Coulombs and mass m kg enters the field with velocity v m/s under the following conditions:
   a. Velocity perpendicular to magnetic field
   b. Angle between the directions of velocity and magnetic field is an acute angle.
   Indicate the trajectory of motion of charged particle and derive the concerned mathematical relationship in each case. [Winter-2005] (8)

6. Describe/Discuss the motion of electron (Charged particle) when projected at an acute angle with the direction of uniform electric field and determine:
   a. Maximum distance reached by the electron in the direction of the field.
   b. Time taken to reach maximum distance.
   c. Range of charged particle.
   [Summer-2011], [W-2014, W-2016] (5)

7. Show that an electron moves along a parabolic path when it enters in a uniform electric field applied perpendicular (transverse) to its motion. [Winter-2006(New) S-2015] OR
   Show that the trajectory made by an electron follows the equation \( y=kx^2 \), when it enters into a transverse uniform electric field. [Summer-2014] (4)

8. Show that an electron traces a parabolic path when it enters in a transverse uniform electric field. W-2016

9. Prove that the path travelled by the electron in an uniform transverse electric field is parabola. [S-2013] (3)

10. Discuss the motion of an electron projected into uniform electric field at an acute angle with the field direction.

11. If a moving electron has no deflection in passing through certain region of space, can we be sure that there is no magnetic field in the region? If it is deflected sideways can we be sure that a magnetic field exists in that region? [Summer-2000] (4)

12. State the shapes of trajectories of a charged particles of velocity \( v \) moving in an electric field E when
   i) \( v \) is perpendicular to E
   ii) \( v \) makes acute angle with E
   What are these shapes if E is replaced by Magnetic field B? [Winter-2003] Win-2015 (4)

13. State the conditions under which a charged particle moves on a straight line in
   a. an electric field E
   b. a magnetic field B
   c. in a region having both E and B.
   [Winter-2003] (4)

14. Describe the trajectories of electron of mass m, and charge q moving with velocity ‘v’ in
   1. Uniform magnetic field
   2. Uniform electrostatic field
15. In both the cases field is applied perpendicular to the direction of motion of particle. 

[Summer-2004] (8)

16. What is Lorentz Force? Discuss the path traveled by an electron in a uniform transverse electric field. 

[Summer-2006(New)] (6)

17. What is force experienced by a charged particle in i) electric field and ii) magnetic field? Show the energy of a charged particle remains constant when it moves in magnetic field. 

[Summer-2006(Old), Winter-2004)] (4)

18. Show that kinetic energy of a charged particle remains constant when it moves in magnetic field. (S-2015)

19. How is it possible for a charged particle to pass through a combination of electric and magnetic field without any deviation? What will be its velocity? What will happen if the particles are moving slowly or faster than this velocity? 


20. Derive an expression for the radius and time period for an electron in a Transverse magnetic field. [Summer-2007(Old)] (3)

21. Show that electron moves along a circular path when it enters a transverse uniform magnetic field. 

[Summer-2009] (3)

22. Explain why slower particles and faster particles require the same time for completing one rotation in magnetic field. [S-2014] (3)

23. Prove that an electron moves along a parabolic path when it enters in a uniform electric field applied perpendicular to its motion. What will happen if the electric field is not uniform? [Summer-2002] (5)

24. When and why a charged particle entering magnetic field follows a helical path. Obtain the expression for the pitch of helix. [Summer-2001] (4) [WK-12] (2+3)

25. Explain how a charged particle describes a helical path in a uniform magnetic field. Obtain the expression for the pitch, radius and time period of the helix. [Summer-2010] (5)Win-2015 (4)

26. When and why charged particle follows helical or spiral path? Obtain the expression for pitch of helix. [Winter 2012 old]

27. Explain why charged particle follows helical or spiral path? Derive the expression for pitch of helix. W-2016

28. Magnetic field changes the velocity of a charge particle without changing its speed, Explain. 

[Summer-2001] (3)

29. Explain how a charged particle fired into uniform electric field describes a parabolic motion and when fired into a uniform magnetic field describes circular and helical motion. Find the expression for radius of the circle and pitch of the helix.[Winter-2002] (6) [Winter-2014 , W-2015]

30. Obtain the expressions of radius and pitch of helical path described by the charged particle when it enters the uniform magnetic field making an acute angle \( \theta \) with the direction of magnetic field. [Summer-2008] [S-2013, New]

31. How can a charged particle be made to travel helical path in uniform magnetic field? Obtain an expression for pitch of this helix.[Winter -2000] (5)

32. Show that charged particle does not gain additional kinetic energy when it travels in uniform transverse magnetic field. [Summer-2003] (3)

33. Show that the velocity acquired by an electron in uniform electrostatic field varies as the square root of potential difference through which it is accelerated. [Winter -2009] (3) [Winter -2014] Win-2015 (3)

34. Explain the working of a velocity selector [Summer-2010,Winter- 2013 , Summer-14, S-2015, W-2016]

35. Explain the function of a velocity filter [Summer-2013] Win-2015 (3)
37. Explain why slower particles and faster particles require the same time for completing one rotation in magnetic field? [Sum-2011] (3)
38. Discuss the motion of an electron projected into the transverse magnetic field. [W2013] (4)
39. Discuss the motion of an electron when it is projected at an angle with direction of uniform electric field. [Winter 2013] (4)

UNIT – III
ELECTRON OPTICS (THEORY)

Bethe’s Law
1. Discuss the refraction of electron beam across an equipotential surface. Hence explain the working of electrostatic lens. [Summer-2007(Old), Summer-2001, Winter-2000] (6) [Winter-2012] (4)
2. What is Bethe’s law? In what way it resembles the Snell’s law and in what way it resembles and differs from it. [Winter-2006(Old), Summer-2004] (4)
3. What is Bethe’s law? Show that this concept helps in understanding the focusing electron beam by a symmetrical electron lens. [Winter-2005, Summer-2006(Old)] (5)
4. Explain briefly the electrostatic focusing. [Summer 2005 (3)]
5. What is Bethe’s law? Discuss the refraction of electron beam across equipotential regions. [Sum-2011] (1+3)
6. What is Bethe’s law? Discuss similarity and differences between Bethe’s law and Snell’s law. [Summer-2013] (3) [Winter-2013] (3)
8. Explain the Bethe’s law with necessary diagram and state its similarities with Snell’s law. [Winter-2013, Winter-2014]
9. Discuss the refraction of electron beam across an equipotential surface. [Winter-2015]
10. What is Bethe’s law? Discuss the refraction of electron beam across the boundary separating two equipotential regions [S-2015]
11. State the law that govern the refraction of electrons. In what way it resembles the Snell’s law and in what way it differs from it. [Winter-16]
12. Explain Bethe’s law of electron refraction. [S-2016]

CRT
13. Draw a schematic of an electrostatic CRT. Describe the role of Electron Gun, Deflection system, Fluorescent screen, Acquadag coating [Summer-2007(New)] (5) [Winter-2014] [S-2016]
14. What is the need of the aquadag coating inside the glass bulb in a CRT? [Summer-2000]
15. Explain the function of aquadag coating on the screen of CRT. [Summer-2013] (2) [S-2015] [Winter-16]
16. Derive an expression for electrostatic deflection sensitivity or vertical deflection of a CRT in terms of d, V, l, L where the terms have their usual meaning. [Summer-2007(Old)] (7), [Winter-2004] (5)

CRO
17. Draw the block diagram of CRO and explain the function of time base generator. [Summer-2012] (5) [Winter-2013] (4)
18. Draw the block diagram of CRO and explain how intensity of trace is controlled on screen. [Summer-2013] (4) [Winter-2014] [Winter-16]
19. Draw the block diagram of CRO and explain the working and use of time base circuit. [Winter-2012] (2+4), [Summer-2014] (4)
20. Draw the block diagram of CRO. Explain the role of electron gun. [Winter-2015]
21. Draw the block diagram of CRO. [S-2015]
22. Draw the block diagram of CRO and explain the necessity of time base circuit and trigger circuit in it [Summer-2005] (3) [Summer-2006(New)] (3) [Summer-2006(Old)] (5) [Winter-2006(New)] (6) [Summer-2003] (5) [Summer-2007(Old)] (4) [Summer-2001] (3)
23. Explain the function / working of each block. [Winter-2006(Old)] (6) [Winter-2005] (7)
24. Explain how intensity and sharpness of the trace on the screen is controlled [Winter-2004] (5)
25. Draw the block diagram of Cathode Ray Oscilloscope and explain the various parts. [Summer-2008]
26. Draw the block diagram of Cathode Ray Oscilloscope and explain the various parts. [Summer-2008]
27. Draw the block diagram of Cathode Ray Oscilloscope and state the functions of different blocks. [Winter-2009]
28. How can the frequency of AC mains be determined using CRO? Explain. [Summer-2005] (3)
29. Draw the block diagram of CRO. What is the function of
Time base circuit, Trigger circuit [Summer-2010] (3+3=6)
30. Show using a graphical method that the resultant of sinusoidal voltage applied to the Y-Input and time base voltage applied to the X input is a sine wave. Which figure will be observed on the CRO screen if sinusoidal voltage to the Y input is replaced by i) Square wave voltage ii) Saw tooth Voltage [Winter-2003] (5)
31. Explain how the actual waveform of the signal can be traced on the CRO screen with the help of time base generator. [Summer-2005] (3)
32. What is synchronization? How is it achieved in CRO? Explain how sharpness of the trace is controlled in CRO? [Summer-2011] (1+2+2) [Summer-2014]
33. What are Lissajous patterns? Define synchronization. How the intensity of the trace on the screen is controlled? [S-2016]

**CYCLOTRON**

34. With a well labeled diagram explain the construction and working of Cyclotron. [Summer-2006(New)] (6)
35. What are its limitations? [Summer-2007 (New)] (5)
36. State the limitations to attain maximum particle energy in Cyclotron. [Summer-2006(Old)] (5)
37. Explain the theory and construction of a Cyclotron. Also obtain the expression for maximum kinetic energy of a charged particle in a cyclotron in terms of radius of dees. Hence obtain the condition of resonance. [Winter-2006(Old)]
38. Explain the construction and working of Cyclotron with the help of neat diagram.
39. Describe construction and working of a Cyclotron and state its limitation. [W-2014] [S-2015]
40. Explain the construction and working of Cyclotron. In the context, obtain the expression for resonance condition and ii) maximum kinetic energy gain for a charged particle. [Winter-2009] (6)
41. What is the primary function of electric and magnetic fields in a Cyclotron? [Summer-2001] (3)
42. What is Cyclotron? State resonance condition. Why can electrons not be accelerated to high energies in Cyclotron. [Summer-2010] (1+1+2=4)
43. With a well labeled diagram, explain the principle, construction and working of a cyclotron. Obtain the resonance condition for cyclotron. [Summer-2014]
44. What is Cyclotron? State resonance condition. What is the role of electric field and magnetic fields in Cyclotron. [W-2015], [S-2016]
45. In cyclotron obtain the expression for
i) Resonance condition and
ii) Maximum kinetic energy gain, for a charged particle. [Winter-16]

**Bainbridge Mass Spectrograph**

46. Explain the construction of Bainbridge mass spectrograph. [Summer-2012](5)
47. What is mass spectrophotogram? Explain the working of velocity selector arrangement in Bainbridge mass spectrograph. Show that the mass scale is linear. [Winter-2005, Summer-2006(New), Summer-2001, Summer –2004, Winter-2006(Old), Summer-2005] (6)
48. Describe the working principle of a Bainbridge mass spectrograph with a neat sketch. [Summer-2013](5)
49. Explain the construction and working of Bainbridge mass spectrograph. [Winter-2013](5) [Winter-2015]
50. Explain in brief the principles involved in the following devices:- 1) Bainbridge Mass Spectrograph

2) Cyclotron.
**OPTICAL FIBER**

1. What is an optical fibre? Explain the principle involved in its working. [S-2013] (4)
2. Derive an expression for an acceptance angle and numerical apertures for an optical fiber with help of suitable diagram. [Summer 2012](5)
3. What is meant by acceptance angle for an optical fibre? Derive an expression how it is related to numerical aperture? [Winter-2012] (2+3) [SUM-15](4)
4. DEDUCE AN expression for acceptance angle of an optical fiber [Winter-15](4)
5. Explain;
   i) Total internal Reflection
   ii) Optical fiber as temperature sensor. [Summer 2012](4)
6. Draw a block diagram of optical fiber communication system and explain the function of each block.
7. Give structure of optical fibers. Explain function of each part.
8. Give the advantages of optical fibers over copper conducts.
10. a) What are different types of optical fibers?
    b) Compare a single mode and a multimode fiber.
11. Give comparative merits & demerits of step – index fiber and graded index fiber
12. What is the difference between a step index fiber and graded index fiber (SK9) [ W-2012 ] (2)
13. Differentiate between step index fiber and graded index fibre. [SUM-15]
14. Explain with refractive index profile step index and graded index fibre. (SK10) (3)
15. Derive the mathematical expression for numerical apertures and acceptance angle for step index fibre. (WK9) (5)
16. Derive an expression for numerical aperture of a step index fiber in terms of \( \Delta \). (SK7) (5)
17. Derive the expression for the numerical aperture of step index fiber. Show that it does not depend on the physical dimensions of the fiber.
18. Derive the expression for the Critical angle of step index fiber.
19. Deduce an expression for acceptance angle of an optical fibre (SK10) (4)
20. Explain the following terms :-
   (i) Critical angle (ii) Acceptance cone & (iii) Numerical Aperture Sk6 (6)
21. Explain the term: a) Numerical aperture b) acceptance angle c) acceptance cone.
22. What is fractional index change (\( \Delta \))? How is it related to numerical aperture?
23. Describe the various mechanisms of attenuation in optical fibers. (SK7) (4)
24. What is attenuation in optical fiber? State the different different mechanisms that contribute to attenuation. [WINTER-15] (4)
25. What is attenuation in fiber optics? What are the different transmission losses associated with optical fibers? Explain in brief any one of them. (SK9) (4)
26. Explain why light signals are attenuated in the optical fiber.
27. What are the different light sources and detectors used for optical fiber?
28. What are the performance requirements for detectors used for optical fiber?
29. Explain the working principle of a simple detector.
30. Explain any one application of the optical fiber as a sensor. (Sk6) (SK10) (3)
31. **Write in brief about the classification of the optical fibres based on material.** (WK9)
32. Discuss how optical fiber can be used as a sensor.
33. What is optical fiber? State at least three of its applications (SK9) (4)
34. Explain the different mechanism that contributes to dispersion in optical fiber. Sum-2011 (4)
35. What are the advantages of optical fiber over conventional cable? Sum-2011 (2)
36. Discuss the advantages of optical fiber over conventional communication system. **Sum-2011 (2)**
   [Winter-2012] (3)
37. Discuss the application of optical fiber as a temperature sensor. **Sum-2011(3)**
38. Discuss the working of optical fiber as a temperature sensor. **Sum-2013(3)**

**Nanoscience**

1. Write a short note on nanoscience.
2. What is nano, Nanoscience, nanotechnology?
3. Why do nanomaterials exhibit different properties? **OR**
4. Why do properties of materials change at nanoscale?
5. What are nanomaterials? Give their classifications?
6. Describe Top-down and bottom-up techniques for preparation of nanomaterials
   **OR**
8. How are nanomaterials synthesized? Describe any two methods.
9. What are the approaches used for the synthesis of nano-materials? Describe any one method. [winter-15]
10. Explain how nanoparticles are deposited by physical vapour deposition. **OR**
11. Discuss the synthesis of nanomaterials physical vapour deposition techniques.
12. Discuss the synthesis of nanoparticles by sol-gel method in detail.
13. Explain how some of the physical properties change at the nanoscale in the case of nanoclusters.
14. How does the property of nanomaterials differ from bulk materials? **[Summer-2013](4) [WINTER-15] (3)**
   **OR**
15. Compare the properties of nanomaterials with Bulk materials. **OR**
16. How optical, physical and chemical properties of nanoparticles are varying with their size?
17. How electrical, mechanical, and magnetic properties of nanoparticles are varying with their size?
18. Describe the impact of Nanotechnology on society **[SUM-15] (3)**
19. What are the important applications of nanomaterials?
20. State the applications of nano-materials in engineering. **[Summer-2013] (3)**
21. What is a carbon nanotube? Explain the different types of carbon nanotubes.
22. How is the carbon nanotubes synthesized? Describe any two methods
23. What are the different types of carbon nanotubes? What are their properties?
24. Discuss the characteristics and properties of carbon nanotubes?
25. Explain physical properties of nanotubes.
26. Write a note on carbon nanotubes.
27. What are the important applications of nanotubes?
29. What are zeolites? Give their properties and applications **[Summer-2013] (3)**
30. What is graphene? Give their properties and applications
31. Write short on:
   - Graphene ii) Fullerene iii) Zeolites **[WINER-15] [sum-15](4)**
32. Explain the impact of nanotechnology and Nanoscience in modern world.
33. Write the important applications of nanomaterials in
   - Energy ii) Information and communication iii) Nanoelectronics