SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF PHYSICS

QUESTION BANK

II SEMESTER

1920202 - PHYSICS FOR INFORMATION SCIENCE

(Common to AI&DS, CSE, Cyber Security and IT)

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DEPARTMENT OF PHYSICS

SUBJECT: 1920202 - PHYSICS FOR INFORMATION SCIENCE
SEM/YEAR: II SEM / AY-2022-2023

UNIT I - ELECTRICAL PROPERTIES OF MATERIALS

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity expression - Wiedemann-Franz law – Success and failures – Quantum free electron theory – degenerate states- Fermi- Dirac distribution function – Density of energy states – Electron in periodic potential – Energy bands in solids; conductors, semiconductors and insulators.

PART – A

S.No	Questions	Level	Competence
1.	Define drift velocity.	BTL1	Remembering
2.	What is meant by the mobility of electrons?	BTL1	Remembering
3.	What is relaxation time?	BTL1	Remembering
4.	Calculate the drift velocity of the free electron with the mobility of 3.5×10^{-3} $m^2V^{-1}s^{-1}$ in copper for an electric field strength of 0.5 V/m.	BTL3	Applying
5.	A conducting rod contains 8.5×10^{28} electrons per m^3. Calculate theelectrical conductivity at room temperature if the collision time for the electron is 2×10^{-14} s.	BTL3	Applying
6.	The mobility of electrons in copper is 3×10^{-3} m^2/Vs. Assuming e = 1.6×10^{-19} C and $m_e = 9.1 \times 10^{-31}$ kg. Calculate the mean free time.	BTL3	Applying
7.	List any two merits of the classical free electron theory of metals.	BTL1	Remembering
8.	Write any two drawbacks of the classical free electron theory of metals.	BTL2	Understanding
9.	Define electrical conductivity.	BTL1	Remembering
10.	Define thermal conductivity.	BTL1	Remembering
11.	Write any two postulates of the quantum free electron theory.	BTL2	Understanding
12.	State Wiedemann-Franz law.	BTL1	Remembering
13.	Define Lorentz number.	BTL1	Remembering
14.	The thermal conductivity of copper at 300 K is 470 W/m/K. Calculate the electrical conductivity. Given Lorentz number, L= 2.45×10^{-8} $W\Omega K^{-2}$.	BTL3	Applying
15.	The thermal and electrical conductivities of copper at 20°C are 390 W/m/K and 5.87×10^{7} Ω^{-1} m^{-1} respectively. Calculate the Lorentz number	BTL3	Applying
16.	What are degenerate states?	BTL1	Remembering
17.	What is meant by Fermi energy level?	BTL1	Remembering

18.	Define Fermi distribution function.	BTL1	Remembering
19.	Draw the Fermi distribution curve at any temperature T > 0 K.	BTL3	Applying
20.	Evaluate the Fermi function for energy K_BT above the Fermi energy.	BTL1	Remembering
21.	Define the density of energy states.	BTL1	Remembering
22.	Interpret how electrons move in a periodic potential.	BTL2	Understanding
23.	What are the valence band and conduction band?	BTL1	Remembering
24.	Define forbidden energy gap in the energy band structure.	BTL1	Remembering

PART -B

S.No	Questions	Level	Competence
1.	(i) Explain the assumptions of classical free electron theory with its merits and demerits. (10) (ii) Calculate the electrical conductivity and Lorentz number for a metal with thermal conductivity 123.92 W/m/K and relaxation time 10^{-14} seconds at 300 K. (Density of electrons = 6 x10^{28} m^{-3}). (3)	BTL2	Understanding
2.	Deduce an expression for the electrical conductivity of a conducting material using classical free electron theory and list its merits and demerits. (13)	BTL1	Remembering
3.	Using classical free electron theory, derive an expression for the electrical conductivity and thermal conductivity of a conducting material. (13)	BTL1	Remembering
4.	(i) Derive an expression for the electrical conductivity of a metal. (10) (ii)A copper wire having a cross-sectional area of 1 mm^2 carries a current of 10 A. Find the drift velocity. Given n = 8.5 x 10^{28} electrons per m^3. (3)	BTL1	Remembering
5.	Derive an expression for the thermal conductivity of a conducting material. (13)	BTL1	Remembering
6.	(i) Write any three postulates of the classical free electron theory. (3) (ii) Deduce an expression for the thermal conductivity of a conducting material. (10)	BTL1	Remembering
7.	Obtain Wiedemann Franz law using the expressions of electrical andthermal conductivity. (13)	BTL2	Understanding
8.	Derive the mathematical expression for electrical conductivity and thermal conductivity of a conducting material and hence obtain the Wiedemann-Franz law. (13)	BTL1	Remembering
9.	(i) Write an expression for Fermi Dirac distribution function F(E) and discuss the effect of temperature on the Fermi function with neat diagrams. (10) (ii) Calculate Fermi distribution function F (E) for the energy level lying 0.01 eV above the Fermi level at 270 K. (3)	BTL4	Analyzing
10	Discuss the Fermi Dirac distribution function and explain its variation with temperature. (13)	BTL4	Analyzing
11.	Define Fermi energy. Explain the Fermi Dirac distribution function for electrons in a metal and discuss the effect of temperature on Fermi function. (13)	BTL2	Understanding
12.	Derive an expression for the density of energy states for a metal. (13)	BTL1	Remembering
13.	Derive an expression for the number of energy states per unit volume of metal. (13)	BTL1	Remembering

14.	Deduce the expression, $Z(E)dE = (4\pi/h^3)\ (2m)^{3/2}E^{1/2}dE$ from the number of energy states between E and E +dE. (13)	BTL1	Remembering
15.	Write a note on (i) Electron in a periodic potential. (6) (ii) Energy bands in a solid. (7)	BTL2	Understanding
16.	Explain energy bands in conductors, semiconductors and insulators, with examples. (13)	BTL2	Understanding
17.	Discuss the classification of materials based on the band theory of solids. (13)	BTL1	Remembering

PART – C

S.No	Questions	Level	Competence
1.	Based on the free electron theory of metals, derive an expression for Lorentz number. (15)	BTL1	Remembering
2.	State and prove Wiedemann-Franz law using the classical free electron theory of metal. (15)	BTL1	Remembering
3.	The electrons of conducting material have different states at a particular energy level. Formulate mathematically an expression for density of energy states. (15)	BTL4	Analyzing
4.	F (E) represents the probability of an electron occupying the energy state. Find the solution for the Fermi distribution function and summarize the effects of temperature on the Fermi function with a neat diagram. (15)	BTL4	Analyzing
5.	Energy levels and bands are a convenient way of representing a solid material. With a a neat sketch, explain the band theory. (15)	BTL2	Understanding

UNIT II SEMICONDUCTOR PHYSICS

Direct and indirect band gap semiconductors - Intrinsic Semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors –Variation of carrier concentration with temperature – Variation of Fermi level with temperature and impurity concentration –Hall effect- Theory and experiment– Applications.

PART – A

S.No	Questions	Level	Competence
1.	List any two properties of a semiconductor.	BTL1	Remembering
2.	Why semiconductors are having a negative temperature coefficient of resistance?	BTL4	Analyzing
3.	What are the charge carriers in a semiconductor?	BTL1	Remembering
4.	What happens to the conductivity of a semiconductor when temperature increases?	BTL2	Understanding
5.	What are elemental semiconductors?	BTL1	Remembering
6.	What are compound semiconductors?	BTL1	Remembering
7.	Differentiate direct and indirect band gap semiconductors.	BTL1	Remembering
8.	Why elemental semiconductors are called an indirect band gap	BTL4	Analyzing

	semiconductors?		
9.	Why compound semiconductors are preferred for making LEDs?	BTL4	Analyzing
10.	What are intrinsic semiconductors? Give an example.	BTL1	Remembering
11.	Draw an energy band diagram of an intrinsic semiconductor, in the room temperature.	BTL2	Understanding
12.	The intrinsic carrier density at room temperature in Ge is 2.37 x $10^{19}/m^3$. If the electron and hole mobilities are 0.38 and 0.18 $m^2V^{-1}s^{-1}$. Calculate the electrical conductivity.	BTL3	Applying
13.	Find the concentration of holes and electrons in n-type silicon at 300 K, if the conductivity is 3 x 10^4 ohm^{-1} m^{-1}. Given , n_i =1.5 x 10^{16} m^{-3}, μ_e =1300 x 10^{-4} $m^2V^{-1}s^{-1}$	BTL3	Applying
14.	Define doping.	BTL1	Remembering
15.	What are extrinsic semiconductors? Give an example.	BTL1	Remembering
16.	Write the expressions for the Fermi energy of an n-type and p-type semiconductor.	BTL1	Remembering
17.	How p-type semiconductors are obtained?	BTL2	Understanding
18.	Sketch the variation of carrier concentration with temperature in an intrinsic semiconductor.	BTL2	Understanding
19.	What is meant by exhaustion range in an n-type semiconductor?	BTL1	Remembering
20.	State Hall effect.	BTL1	Remembering
21.	How p-type and n-type semiconductors are identified using the Hall coefficient?	BTL1	Remembering
22.	Mention any two applications of the Hall Effect.	BTL1	Remembering
23.	An n-type semiconductor has a Hall coefficient, R_H = 4.16 x 10^{-14} m^3/C. The conductivity is 108 ohm^{-1} m^{-1}. Calculate the charge carrier density, n_e at room temperature.	BTL3	Applying
24.	A silicon plate of thickness 1mm, breadth 10mm, and length 100mm is placed magnetic field of 0.5 Wb/m^2 acting perpendicular to its thickness. If A 10^{-2} current flows along its length, calculate the Hall voltage developed if the Hall coefficient is 3.66×10^{-4} m^3 / coulomb.	BTL3	Applying

PART B

S.No	Questions	Level	Competence
1.	Deduce an expression for density of electrons in a conduction band of an intrinsic semiconductor. (13)	BTL2	Understanding
2.	Derive an expression for concentration of holes in valance band of anintrinsic semiconductor. (13)	BTL2	Understanding
3.	Using density of energy states in the energy range E and E + dE, Show that, the density of hole in the valence band of an intrinsic semiconductor, $p = 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} e^{(E_v - E_F)/kT}$ (13)	BTL2	Understanding
4	Show that, the electron concentration in the conduction band of an intrinsic semiconductor, $n = 2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2} e^{(E_F - E_C)/kT}$ (13)	BTL2	Understanding
5.	Derive an expression for density of electrons in the conduction band and density of holes in the valence band of an intrinsic semiconductor. (13)	BTL1	Remembering
6.	Derive an expression for intrinsic carrier concentration. (13)	BTL1	Remembering

7.	Obtain an expression for carrier concentration of electrons in conduction band of an n-type semiconductor. (13)	BTL1	Remembering
8.	Derive an expression for density of electrons in conduction band of an n-type semiconductor. (13)	BTL1	Remembering
9.	Show that for an n-type semiconductor, density of electron in the conduction band is proportional to the square root of the donor concentration at low temperatures. (13)	BTL2	Understanding
10.	Obtain an expression for carrier concentration of holes in a valance band of a p-type semiconductor. (13)	BTL1	Remembering
11.	Derive an expression for density of holes in a valance band of a p-type semiconductor. (13)	BTL1	Remembering
12.	Show that for a p-type semiconductor, density of holes in the valence band is proportional to the square root of the acceptor concentration at low temperatures. (13)	BTL2	Understanding
13.	Explain the variation of carrier concentration with temperature in an n -type semiconductor. (13)	BTL2	Understanding
14.	With neat diagrams, explain the variation of Fermi level with temperature and impurity concentration in an n-type and p-type semiconductors. (13)	BTL2	Understanding
15.	Obtain an expression for the Hall coefficient of n-type and p-type semiconductor. (13)	BTL1	Remembering
16.	Show that the Hall Coefficient is negative for an n-type semiconductor and positive for p-type semiconductor. (13)	BTL2	Understanding
17.	(i) State Hall effect. Derive an expression for the Hall coefficient of a sample in terms of Hall voltage. (10) (ii)Describe an experimental setup to measure the Hall voltage. (3)	BTL1	Remembering

PART-C

S.No	Questions	Level	Competence
1.	Show that in an intrinsic semiconductor, Fermi energy level (E_F)lies in the midway between highest level of the valance band (E_V) and lowest level of the conduction band (E_C). (15)	BTL3	Applying
2.	(i) Obtain an expression for Fermi energy in terms of donor concentrations of electrons. (10) (ii)Derive an expression for density of electrons (n_e) in conduction band in terms of donor concentration (N_d). (5)	BTL2	Understanding
3.	With neat sketch, show that for p-type semiconductors, density of holes in valence band is proportional to the square root of the acceptor concentration (N_a) at low temperatures. (15)	BTL3	Applying
4.	(i) Show that for an n-type and a p-type semiconductors, the value of Hall coefficients is negative and positive respectively. (10) (ii) Describe an experimental set up for the measurement of Hall voltage. (5)	BTL3	Applying
5.	Derive an expression for Hall coefficient. Describe an experiment for the measurement of the Hall coefficient and mention its applications. (15)	BTL2	Understanding

UNIT III MAGNETIC PROPERTIES OF MATERIALS

Magnetic dipole moment - origin of magnetic moments- Bohr magnetron- magnetic permeability andsusceptibility - Magnetic material classification – Ferromagnetism: Domain theory- Energy involved in domains- Domain Theory- M versus H behavior – Hard and soft magnetic materials – examples and uses saturationmagnetization and Curie temperature – Magnetic hard disc (GMR sensor).

PART – A

S.No	Questions	Level	Competence
1.	Define magnetic dipole.	BTL1	Remembering
2.	What is Bohr Magneton?	BTL2	Understanding
3.	Define the intensity of magnetization.	BTL1	Remembering
4.	Define magnetic flux density.	BTL1	Remembering
5.	Define magnetic permeability.	BTL1	Remembering
6.	Define magnetic susceptibility.	BTL1	Remembering
7.	Iron has a relative permeability of 5000. Calculate its magnetic susceptibility.	BTL3	Applying
8.	The magnetic field intensity and susceptibility of a piece of ferric oxide is 10^6 A/m and 1.5 x 10^{-3} respectively. Find the magnetization of the material.	BTL3	Applying
9.	The magnetic field strength of a material is 10^4A/m and the susceptibilityis 3.7 x 10^{-3}. Calculate the intensity of magnetization.	BTL3	Applying
10.	A material has a permeability of 0.1 H/m when the magnetic intensity is20 A/m. Calculate the magnetic induction inside the material.	BTL3	Applying
11.	Classify the magnetic materials based on their spin arrangements.	BTL2	Understanding
12.	What happens to the magnetic flux, when a diamagnetic material is kept in a magnetic field?	BTL2	Understanding
13.	Write a note on spontaneous magnetization.	BTL2	Understanding
14.	What are magnetic domains?	BTL2	Understanding
15.	Mention the four types of energies involved in the growth of magnetic domains.	BTL1	Remembering
16.	What is meant by hysteresis loop?	BTL2	Understanding
17.	What is meant by the term retentivity?	BTL1	Remembering
18.	Differentiate soft and hard magnetic materials.	BTL2	Understanding
19.	Why soft magnetic materials are used in electromagnets?	BTL3	Applying
20.	Define Curie temperature.	BTL1	Remembering
21.	Define Giant Magneto-resistance.	BTL1	Remembering
22.	List any two advantages of magnetic disks.	BTL1	Remembering
23.	Give any two examples of magnetic data storage devices.	BTL1	Remembering
24.	Write any two applications of magnetic hard disk drives.	BTL2	Understanding

PART -B

S.No	Questions	Level	Competence
1.	Explain the classification of magnetic materials based on their spins. (13)	BTL2	Understanding

2.	Compare dia, para and ferromagnetic materials on the basis of spin. (13)	BTL2	Understanding
3.	(i) What is meant by Ferromagnetism? (3) (ii) Explain with neat diagrams, how the magnetization occurs in a ferromagnetic magnetic material, after the application of a magnetic field. (10)	BTL2	Understanding
4.	Explain ferromagnetic domain theory. (13)	BTL2	Understanding
5.	Describe the domain theory of ferromagnetism. (13)	BTL2	Understanding
6.	Explain different types of energy involved in domain growth. (13)	BTL2	Understanding
7.	Explain the different types of energies that are responsible for the growth ofdomains in a ferromagnetic material. (13)	BTL2	Understanding
8.	(i) Draw the M-H curve (Hysteresis) for a ferromagnetic material. (3) (ii) Explain the hysteresis curve based on domain theory. (10)	BTL2	Understanding
9.	(i) Define the term coercivity and retentivity. (3) (ii) Explain the lagging of magnetization behind the magnetizing field with the help of an M-H curve. (10)	BTL2	Understanding
10.	What are reversible and irreversible domains? Based on that explain the phenomenon of hysteresis in ferromagnetic materials. (13)	BTL2	Understanding
11.	Explain the formation of the hysteresis loop using domain wall movement. (13)	BTL2	Understanding
12.	(i)What are soft and hard magnetic materials? (3) (ii)Write the differences between soft and hard magnetic materials. (10)	BTL2	Understanding
13.	(i)Explain the hysteresis curve based on domain theory. (9) (ii)Distinguish soft and hard magnetic materials (4)	BTL2	Understanding
14.	(i)Write a short note on M-H curve hysteresis. (6) (ii)Differentiate soft and hard magnetic materials. (7)	BTL2	Understanding
15.	Explain the magnetic data storage in computer hard disc. (13)	BTL2	Understanding
16.	Describe the working of magnetic hard disc based on GMR sensor. Mention its advantages and disadvantages. (13)	BTL2	Understanding
17.	Explain the writing and reading of data in magnetic hard disk using GMR sensors. (13)	BTL2	Understanding

PART – C

S.No	Questions	Level	Competence
1.	With necessary diagrams and examples, compare the properties ofmagnetic materials based on their spins. (15)	BTL2	Understanding
2.	Discuss the spontaneous magnetization of ferromagnetic materialswith the help of domains. Compile the theory based on the energy involved in the ferromagnetic material. (15)	BTL2	Understanding
3.	Plot an M – H curve(hysteresis) and explain the magnetic hysteresis loop formation on the basis of the domain theory of ferromagnetism. (15)	BTL3	Analyzing
4.	(i)Describe the magnetic hysteresis loop formation on the basis of the domain theory of ferromagnetism. (10) (ii)Differentiate soft and hard magnetic materials. (5)	BTL2	Understanding
5.	Explain the process of storing the information and the process ofretrieving the information with the help of a GMR sensor. (15)	BTL2	Understanding

UNIT IV OPTICAL PROPERTIES OF MATERIALS

Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and semiconductors (concepts only) – photo current in a P-N diode- solar cell- LED – Organic LED – optical data storage techniques.

PART – A

S. No	Questions	Level	Competence
1.	What are optical materials?	BTL1	Remembering
2.	Classify the optical materials based on their interaction with visible light.	BTL2	Understanding
3.	What are translucent materials?	BTL2	Understanding
4.	What are transparent materials?	BTL1	Remembering
5.	Define carrier generation and recombination.	BTL2	Understanding
6.	What is dark current?	BTL2	Understanding
7.	What is the principle behind the P-N junction diode?	BTL2	Understanding
8.	Write any two advantages of photodiode.	BTL1	Remembering
9.	Give any two applications of cs.	BTL1	Remembering
10.	Write the working principle of solar cells.	BTL2	Understanding
11.	Mention any two merits of solar cells.	BTL1	Remembering
12.	Give any two disadvantages of solar cells.	BTL1	Remembering
13.	List any two applications of solar cells.	BTL1	Remembering
14.	Write a note on Light Emitting Diode?	BTL2	Understanding
15.	What is minority charge carrier injection?	BTL2	Understanding
16.	List any two advantages of LED in electronic display.	BTL1	Remembering
17.	Justify, why LEDs are preferred to have a hemispherical shape.	BTL2	Understanding
18.	Calculate the wavelength of radiation emitted by an LED with a band gapenergy of 2.8 eV.	BTL3	Applying
19.	The wavelength of light emission in an LED is 1.55μm. Calculate the band gap in eV.	BTL3	Applying
20.	Write the principle of OLED.	BTL2	Understanding
21.	Name the main two layers in an OLED.	BTL2	Understanding
22.	Mention any two advantages of OLED.	BTL1	Remembering
23.	Give any two recent applications of OLED.	BTL2	Understanding
24.	Name any two optical data storage techniques.	BTL1	Remembering

PART-B

S. No	Questions	Level	Competence
1.	Describe about the absorption and emission of light in metals, semiconductors and insulators. (13)	BTL2	Understanding
2.	Summarize the three types of carrier generations and recombination processes in semiconductors. (13)	BTL2	Understanding

3.	(i) Explain three types of scattering of light in solids. (7) (ii) Define (a) Transparent materials (b) Translucent materials (c) Opaque materials. (2+2+2)	BTL1	Remembering
4.	Explain the principle, construction and working of a photodiode with necessary diagrams. (13)	BTL2	Understanding
5.	With neat diagrams, explain the process that takes place when a reverse-biased P-N junction diode is exposed to light. Also, write down its merits and demerits. (13)	BTL2	Understanding
6.	Describe the principle, construction and working of a solar cell with a neat diagram. Also, mention any four applications. (13)	BTL2	Understanding
7.	Explain the principle and workings of a large-area photovoltaic device which converts sunlight directly into electricity. (13)	BTL2	Understanding
8.	Explain the working of the photovoltaic device which uses a renewable energy source. (13)	BTL2	Understanding
9.	What is meant by minority charge carrier injection? Explain how a P-N junction diode acts as a LED. (13)	BTL2	Understanding
10.	Explain the principle and working of LED with a neat diagram and mention its advantages and disadvantages. (13)	BTL2	Understanding
11.	Describe the construction and working of a light-emitting diode along with its merits and demerits. (13)	BTL2	Understanding
12.	Explain the principle, construction and working of OLED. (13)	BTL2	Understanding
13.	Explain the construction and working of an optoelectronic device made up of many layers with organic molecules of different conductivity levels. (13)	BTL2	Understanding
14.	Describe the principle, construction and working of an Organic Light Emitting Diode. (13)	BTL2	Understanding
15.	What are the layers used in an OLED? Explain the working of an OLED. (13)	BTL2	Understanding
16.	List out the different types of optical data storage techniques and describe any one technique. (13)	BTL1	Remembering
17.	Explain the process of storing and retrieving the data by optical storage techniques, with neat diagrams. (13)	BTL2	Understanding

PART – C

S.No	Questions	Level	Competence
1.	(i) Classify the material based on the interactions with visible light. (5) Explain the principle, construction and working of P-N junction diode under reverse bias condition. (10)	BTL2	Understanding
2.	Design a solar cell circuit and explain the principle, construction and working of it, when it is exposed to sunlight along with its advantages anddisadvantages. (15)	BTL3	Applying
3.	Explain the principle, construction, and working of an LED along with its advantages, disadvantages and applications. (15)	BTL2	Understanding
4.	Construct a semiconductor light source with thin films of organic molecules that emit light due to recombination of electrons and holes. Explain the principle and working of the device with a neat diagram. (15)	BTL3	Applying
5.	With neat diagrams, describe the optical data storage technique. (15)	BTL2	Understanding

UNIT V NANOMATERIALS AND DEVICES

Introduction – Size dependence of Fermi energy – Quantum confinement – Quantum structures – Density of energy states in quantum well, quantum wire and quantum dot structure - Band gap of nanomaterials – Tunnelling: single electron phenomena and single electron transistor – Quantum dot laser – Carbon nanotubes:Properties and applications.

PART – A

S.No	Questions	Level	Competence
1.	What are nanomaterials?	BTL2	Understanding
2.	The Fermi energy of a material varies with its size. Justify.	BTL2	Understanding
3.	What happens to the band gap when a solid material is reduced into a nanomaterial?	BTL2	Understanding
4.	What is meant by quantum confinement?	BTL1	Remembering
5.	What is meant by quantum confined structure?	BTL1	Remembering
6.	Define the term quantum dot.	BTL1	Remembering
7.	Define the term quantum wire	BTL1	Remembering
8.	Define the term quantum well.	BTL1	Remembering
9.	List any two applications of the quantum dot.	BTL1	Remembering
10.	Mention any two applications of the quantum wire.	BTL1	Remembering
11.	Write any two applications of the quantum well.	BTL1	Remembering
12.	How the density of states is proportional to the energy in one dimension, two dimensions and three dimensions?	BTL4	Analyzing
13.	What is meant by quantum tunnelling?	BTL1	Remembering
14.	Define coulomb blockade.	BTL1	Remembering
15.	How coulomb blockade prevents unwanted tunneling?	BTL4	Analyzing
16.	What is meant by a single electron transistor (SET)?	BTL2	Understanding
17.	What are the limitations of single electron transistor?	BTL2	Understanding
18.	Mention the two conditions for the single electron phenomena to occur.	BTL1	Remembering
19.	Write any two advantages of quantum dot laser.	BTL1	Remembering
20.	Name any two applications of quantum dot laser.	BTL1	Remembering
21.	What are carbon nano tubes (CNTs)?	BTL2	Understanding
22.	Based on the rolling of the graphene sheet, how carbon nano tubes are classified?	BTL2	Understanding
23.	List any two properties of carbon nano tubes.	BTL2	Understanding
24.	Mention any two applications of CNT.	BTL2	Understanding

PART-B

S.No	Questions	Level	Competence
1.	Explain the electron density in bulk materials and its size dependence with Fermi energy. (13)	BTL2	Understanding
2.	Describe quantum confinement and quantum structures in nanomaterials. (13)	BTL2	Understanding
3.	Discuss the density of states in quantum well, quantum wire and quantum dot.	BTL2	Understanding

	(13)		
4.	Derive an expression for density of states in zero-dimension, one dimension and two dimension quantum confinement structures. (13)	BTL1	Remembering
5.	Explain single electron phenomena. (13)	BTL2	Understanding
6.	Describe single electron phenomena and single electron transistors. (13)	BTL2	Understanding
7.	Describe the construction and working of a single electron transistor. (13)	BTL2	Understanding
8.	Using single electron phenom, explain the construction and working of single electron transistors. (13)	BTL2	Understanding
9.	Explain the tunnelling phenomenon. Mention the conditions necessary for the single electron phenomenon to occur. (13)	BTL4	Analyzing
10.	Describe the working of a semiconductor laser in which the active medium is embedded with quantum dots. (10) Mention any one advantage, disadvantage and application. (3)	BTL3	Applying
11.	Explain quantum dot lasers. Write its applications. (13)	BTL2	Understanding
12.	Describe the construction and working of a quantum dot laser. (13)	BTL2	Understanding
13.	Construct and discuss the working of an active region using a material whose all three dimensions are minimized which acts as a light emitter. (13)	BTL2	Understanding
14.	Explain carbon nanotubes with their properties and applications. (13)	BTL2	Understanding
15.	Describe the CNT structures with their properties and applications. (13)	BTL2	Understanding
16.	What is a carbon nano tube? Explain the properties and applications of carbon nano tubes. (13)	BTL2	Understanding
17	Mention the physical properties and applications of CNT. (13)	BTL1	Remembering
	PART – C		
S.No	**Questions**	**Level**	**Competence**
1.	Elaborate mathematically how we can confine the motion of randomly moving electrons to restrict its motion in specific energy levels with respect toone, two, or three dimensions in solids which leads to increase electronic band gaps. (15)	BTL2	Understanding
2.	Describe the construction, working, advantages and disadvantages of quantum dot laser which can tune the wavelength by changing the dot size. (15)	BTL2	Understanding
3.	(i) Explain the working of a quantum dot laser in which the active medium is embedded with quantum dots. (10) (ii)Mention the advantages, disadvantages and applications of quantum dot lasers. (5)	BTL2	Understanding
4.	Design a transistor in which the current flows from source to drain due to movement of only one electron at a time. Explain the conditions necessary for this single electron phenomenon and the working of the Single electron transistor. (15)	BTL3	Applying
5.	Explain the types, properties and applications of carbon nano tubes. (15)	BTL2	Understanding