SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF PHYSICS

QUESTION BANK

I SEMESTER

1920103-ENGINEERING PHYSICS

Academic Year 2022 – 2023

Prepared by

Dr. H.Krishnan, Dr. M.Anbuchezhiyan, Dr. K.Thiruppathi, Mrs.D.Praveena,

Dr. S.Gandhimathi, Dr. R. Nithya Balaji, , Mrs.R.Sasireka,

Mrs. S.Sowmiya, Mrs.Ramya Rajan.M.P & Dr. S. Padmaja.

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SUBJECT : 1920103- ENGINEERING PHYSICS

SEM / YEAR : I SEM/AY-2022-2023

UNIT I - PROPERTIES OF MATTER

Elasticity – Hooke's law-Stress-strain diagram and its uses – Poisson's ratio- factors affecting elastic modulus and tensile strength – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders

PART – A

Q.No	Questions	BT Level	Competence
1.	Define elasticity.	BTL 1	Remembering
2.	State Hooke's law.	BTL 2	Understanding
3.	Define shearing strain.	BTL 1	Remembering
4.	Draw a stress-strain diagram for a brittle and ductile material.	BTL 2	Understanding
5.	What do you infer from the stress and strain diagram?	BTL 2	Understanding
6.	Define elastic limit.	BTL 1	Remembering
7.	What is meant by yield point?	BTL 1	Remembering
8.	A copper wire of 3 m length and 1 mm diameter is subjected to a tension of 5 N. Calculate the elongation produced in the wire if Young's modulus of copper is 120 GPa.	BT L 3	Applying
9.	What force is required to stretch a steel wire to double its length when its area of the cross-section is 1 cm^2 and Young's modulus of elasticity is 2×10^{11} N/m^2?	BT L 3	Applying
10.	State Poisson's ratio.	BTL 1	Remembering
11.	Find the Poisson's ratio for copper if the lateral strain is 3.6×10^{-4} m and the longitudinal strain is 1×10^{-3} m.	BT L 3	Applying
12.	List any two factors which affects the tensile strength of the material.	BTL 2	Understanding
13.	How do impurities in a material affect the elastic property?	BTL 1	Remembering
14.	What happens to the time period, if the diameter of the suspension wire is doubled without changing the length of a torsion pendulum?	BTL 2	Understanding
15.	A cylindrical wire of length 1 m and radius 5 mm is rigidly clamped at one end. Calculate the couple required to twist the free end through an angle 45°. The rigidity modulus of the material of the wire is 200×10^9 Pa.	BT L 3	Applying
16.	Define torque.	BTL 1	Remembering

17.	What is a beam?	BTL 1	Remembering
18.	Define bending moment at a section of a beam.	BTL 1	Remembering
19.	Define neutral axis.	BTL 1	Remembering
20.	How do various filaments of a beam get affected when it is loaded?	BTL 2	Understanding
21.	Calculate the Young's modulus of the material in the cantilever method. The length of cantilever beam is 1m which is suspended with a load of 150 gm. The depression is found to be 4 cm. The thickness of the beam is 5 mm and breadth is 3 cm.	BT L 3	Applying
22.	What is non-uniform bending and why is it said to be non-uniform?	BTL 2	Understanding
23.	Why girders are given I-shaped?	BTL 2	Understanding
24.	How can you reduce depression in an I-shaped girder?	BTL 2	Understanding
	PART – B		
1.	Draw stress - strain diagram and discuss the behavior of a ductile material under loading. (13)	BT L 4	Analyzing
2.	Explain the elastic limit, yield point, ultimate strength and breaking point of an elastic material using stress - strain diagram. (13)	BT L 2	Understanding
3.	Explain the factors which affect the elasticity of the material. (13)	BT L 2	Understanding
4.	Derive an expression for the couple per unit angular twist when a cylinder is twisted. (13)	BT L 3	Applying
5.	(i) Derive an expression for twisting couple of a cylinder. (10) (ii) A wire of length 1 m and diameter 1 mm is clamped at one of its ends. Calculate the couple required to twist the other end by 90°. Given modulus of rigidity = 298 GPa. (3)	BT L 4 BT L 3	Analyzing Applying
6.	(i) Derive an expression for the period of oscillation of a torsional pendulum. (10) (ii) How will you find the rigidity modulus of a wire using a torsion pendulum? (3)	BT L 3 BT L 4	Applying Analyzing
7.	How could you determine the rigidity modulus of a wire using a torsion pendulum? (13)	BT L 4	Analyzing
8.	(i) Derive an expression for the bending moment of a beam. (10) (ii) Deduce the bending moment of a beam for rectangular and circular cross sections. (3)	BT L 3 BT L 3	Applying Applying
9.	Derive an expression for the internal bending moment of a beam in terms of radius of curvature. (13)	BT L 4	Analyzing
10.	Derive an expression for the depression produced at the end of a cantilever beam. (13)	BT L 3	Applying
11.	Derive with relevant theory how a cantilever can be used to determine Young's modulus of the material of a bar. (13)	BT L 3	Applying

12.	(i) Obtain the equation for the depression at the loaded end whose other end is fixed assuming that its own weight is not effective in bending. (10) (ii) At the end of a given strip, the cantilever depresses 10 mm under a certain load. Calculate the depression under the same load for another cantilever of the same material, 2 times its length, 2 times in width, and 3 times its thickness. (3)	BT L 3 BT L 3	Applying Applying
13.	Derive an expression for the elevation at the center of a beam which is loaded at both ends. (13)	BT L 3	Applying
14.	Deduce an expression for Young's modulus of material by the uniform bending method. (13)	BT L 3	Applying
15.	(i) Explain the theory and experiment to find Young's modulus of a material by the non-uniform bending method? (10) (ii) A rectangular bar of 0.02 m breadth, 0.01 m depth and 1 m length, is supported at the ends and a load of 2 kg is applied at its middle. Calculate the depression, if Young's modulus of the material of the bar is $2 \times 10^{11} Nm^{-2}$. (3)	BT L 2 BT L 3	Understanding Applying
16.	Explain the necessary theory and experimental part to determine Young's modulus of the material of a beam supported at its ends and loaded in the middle. (13)	BT L 3	Applying
17.	(i) Write a short note on I-shaped girders. What are the advantages and applications of an I-shaped girder? (7) (ii) A circular and a square cantilever are made of the same material and have an equal area of cross section and length. Find the ratio of their depression, for a given load. (6)	BT L 2 BT L 4	Understanding Analyzing
	PART C		
1.	With a neat diagram, show that twisting couple per unit twist for a cylindrical wire is directly proportional to the fourth power of the radius of the cylinder. (15)	BT L 3	Applying
2.	A disc is suspended by a wire, which twists first in one direction and then in the reverse direction, in the horizontal plane. How this method is used to determine the: a) Moment of inertia of the disc. (8) b) Rigidity modulus of the wire using the moment of inertia. (7)	BT L 4 BT L 3	Analyzing Applying
3.	Cranes are necessary when a considerable area has to be served as in steel stockyards and shipbuilding berths which resemble the cantilever. Derive an expression to find Young's modulus of the given method along with the experimental technique. (15)	BT L 3	Applying
4.	A beam forms an arc of a circle and it gets elevated, when it is loaded. Mention the type of bending formed while loading. Describe an experiment with the necessary theory to find Young's modulus of the given beam. (15)	BT L 4	Analyzing
5.	i) Centrally loaded beam will not form an arc of a circle. Justify. Derive an expression to find Young's modulus of the given beam. (10) ii) Describe an experiment to find Young's modulus of the centrally loaded beam. (5)	BT L 4 BT L 3	Analyzing Applying

UNIT II - LASERS AND FIBER OPTICS

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Nd-YAG laser-Semiconductor lasers: homojunction and heterojunction – Applications.
Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibers (material, refractiveindex, and mode) – losses associated with optical fibers–Fiber optic communication- fiber optic sensors: pressure and displacement- Endoscope.

PART – A

Q.No	Questions	BT Level	Competence
1.	List out the four characteristics of a laser beam.	BTL 1	Remembering
2.	Write the conditions required for laser action.	BTL 1	Remembering
3.	What is population inversion?	BTL 1	Remembering
4.	Differentiate spontaneous emission and stimulated emission.	BTL 2	Understanding
5.	Stimulated emission design is the key to good lasing action. Justify.	BTL 4	Analyzing
6.	Calculate the wavelength of light emission from GaAs whose band gap is 3 eV.	BTL 2	Understanding
7.	What is meant by pumping action?	BTL 1	Remembering
8.	List the different pumping schemes for creating population inversion.	BTL 1	Remembering
9.	What is the term 'active material' in Laser?	BTL 2	Understanding
10.	Write the role of the optical resonator cavity in the laser.	BTL 1	Remembering
11.	Differentiate between a homojunction and a heterojunction laser.	BTL 2	Understanding
12.	An LED emits green light of wavelength λ = 5511.11 Å. Find the band gap of the material used.	BTL 2	Understanding
13.	List the main sections of an optical fiber.	BTL 1	Remembering
14.	Mention the conditions to be satisfied for total internal reflection.	BTL 1	Remembering
15.	Define the term ' acceptance angle' of an optical fiber.	BTL 2	Understanding
16.	Classify the optical fiber type based on the material.	BTL 1	Remembering
17.	Draw a schematic layout of a step-index optical fibre.	BTL 1	Remembering
18.	Write a few differences between single-mode and multimode fibre.	BTL 2	Understanding
19.	What is attenuation?	BTL 1	Remembering
20.	A fiber optic cable has an acceptance angle of 30° and a core index of refraction of 1.4. Calculate the refractive index of the cladding.	BTL 3	Applying
21.	A silica optical fiber has a core refractive index of 1.51 and a cladding refractive index of 1.48. Determine the critical angle at the core-cladding interface.	BTL 3	Applying

22.	Define active and passive fiber optic sensors.	BTL 1	Remembering
23.	Write the advantages of fibre optic communication over radio wave communication.	BTL 2	Remembering
24.	Give any two medical applications of fibre optic endoscopy.	BTL 2	Understanding
	PART – B		
1.	Using the correct expressions, infer the relation between Einstein's coefficient of spontaneous and stimulated emissions. (13)	BTL 3	Applying
2.	(i) What is stimulated emission? (3) (ii) For atomic transitions, derive Einstein's relation and hence deduce the expressions for Einstein's coefficient. (10)	BTL 1 BTL 4	Remembering Analyzing
3.	(i) Outline the principle, construction and working of an Nd-YAG laser. (10) (ii) List any three advantages of the Nd-YAG laser. (3)	BTL 4 BTL 1	Analyzing Remembering
4.	With the help of an energy diagram, illustrate the construction and working of a four-level solid-state laser, where the Nd^{3+} ions act as the active centers. (13)	BTL 3	Applying
5.	(i) Explain the principle, construction and working of any one type of semiconductor diode laser. (10) (ii) Mention the advantages and disadvantages of semiconductor diode lasers. (3)	BTL 4 BTL 1	Analyzing Remembering
6.	(i) With a neat sketch, explain the homojunction semiconductor laser. (8) (ii) Summarize on heterojunction semiconductor laser with a suitable diagram. (5)	BTL 4	Analyzing
7.	(i) Define numerical aperture. (3) (ii) Deduce an expression for the numerical aperture and acceptance angle of fiber in terms of the refractive index of the core and cladding. (10)	BTL 1 BTL 3	Remembering Applying
8.	What is optical fiber? Give the basic principles of light guidance through optical fiber. Derive an expression for the numerical aperture of an optical fiber. (13)	BTL 2	Understanding
9.	Give a detailed classification of the optical fiber-based on material, mode and refractive index. (13)	BTL 4	Analyzing
10	Describe the classification of optical fibres based on refractive index profile and propagation mode . (13)	BTL 2	Understanding
11.	Explain in detail the losses in optical fiber with a basic attenuation mechanism. (13)	BTL 3	Applying
12.	(i) Discuss the Scattering, Bending and Absorption loss in optical fibers. (10) (ii) The optical power after propagating through a fiber of 1.5 km length isreduced to 25 % of its original value. Compute the fiber loss in dB/km. (3)	BTL 2 BTL 3	Understanding Applying

13.	Explain the optical fiber communication system with a suitable block diagram. (13)	BTL 3	Applying
14.	With a neat sketch, discuss the transmission and reception of information signals and their propagation in a Fiber communication system. (13)	BTL 4	Analyzing
15.	(i) Explain the construction and working of the pressure sensor. (7) (ii) Sketch the displacement sensor and discuss its working. (6)	BTL 2 BTL 2	Understanding Understanding
16.	List the different types of fiber optic sensors. Explain the working of any two sensors. (13)	BTL 2	Understanding
17.	i) Summarize the working of fiber optic pressure sensor with a neat sketch. (6) ii) With a neat diagram, explain the construction and working of fiber optic endoscope. (7)	BTL 2 BTL 3	Understanding Applying
	PART C		
1.	Barcode scanners utilize lasers to fetch information about various products. Identify the laser used in it. With the schematic diagram explain the construction and working of the above lasers. (15)	BTL 4	Analyzing
2.	With the necessary description, write the construction and working of a solid state laser source used for cutting complex shapes. (15)	BTL 4	Analyzing
3.	List out and summarize the various losses that has to be taken care of while using optical fiber. (15)	BTL 4	Analyzing
4.	(i) With the necessary block diagram, illustrates how optical fiber can be used in communication. (8) (ii) Analyze the advantages of optical fiber communication over other conventional communication system. (7)	BTL 4	Analyzing
5.	Various sensors are using optical fibers for sensing different physical quantities. With a neat sketch, explain the construction and working of sensors used for monitoring i) Temperature (8) ii) Displacement (7)	BTL 3	Applying
	UNIT III – THERMAL PHYSICS		
	Transfer of heat energy – thermal conduction, convection and radiation – Newton's law cooling (qualitative) -heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.		
	PART – A		
Q.No	**Questions**	**BT Level**	**Competence**
1.	What are the three modes of heat transfer?	BTL 1	Remembering

2.	What is thermal conduction?	BTL 1	Remembering
3.	Define the term convection.	BTL 1	Remembering
4.	In which process the heat transfer can take place without the medium? Justify your answer.	BTL 2	Understanding
5.	Why does a metal chair feel colder to our bare skin than a wooden chair?	BTL 2	Understanding
6.	What are the basic entities responsible for the thermal conduction of a solid?	BTL 2	Understanding
7.	Define the coefficient of thermal conductivity.	BTL 1	Remembering
8.	The ends of two rods A and B with thermal conductivities K_1 and K_2 respectively are maintained at temperatures θ_1 and θ_2. The rods are of equal length. What is the condition under which there will be an equal rate of heat flow through both rods?	BTL 2	Understanding
9.	Define the term thermal gradient.	BTL 2	Understanding
10.	List out two properties of thermal insulation.	BTL 1	Remembering
11.	State Newton's law of cooling.	BTL 1	Remembering
12.	A rod of length 50 cm is heated at one end to 98 °C, while the other end is kept at room temperature (30 °C). The area of cross-section of the rod is 0.67 cm^2. The thermal conductivity of the rod is 81 $Wm^{-1}K^{-1}$. Calculate the amount of heat conducted through the rod in 3 ½ minutes.	BTL 2	Understanding
13.	Calculate the thermal conductivity of the rod with a length of 45 cm, area of cross-section is 0.921×10^{-4} m^2, heated at one end through 412 K, while another end is at 342 K, the amount of heat that flows in 8 min along the rod is 7.128×10^3J.	BTL 2	Understanding
14.	Write the principle involved in Lee's disc method to determine the thermal conductivity of bad conductors.	BTL 2	Understanding
15.	A slab with an area of 73 x 10^{-4} m^2 in which 16 J of heat is flowing through both faces in 15 seconds and a temperature difference of 27 K is maintained. Calculate the thickness of the slab, where its thermal conductivity is 0.01 $Wm^{-1}K^{-1}$.	BTL 2	Understanding
16.	What is meant by thermal insulation?	BTL 1	Remembering
17.	State the principle of refrigeration.	BTL 1	Remembering
18.	List any two refrigerant used in refrigerator.	BTL 1	Remembering
19.	Define oven.	BTL 1	Remembering
20.	Write two applications of oven.	BTL 1	Remembering
21.	What is meant by heat exchanger? How the heat is measured using it?	BTL 1	Remembering

22.	Mention any two applications of heat exchangers.	BTL 1	Remembering
23.	Give the principle of solar water heaters.	BTL 1	Remembering
24.	Write any two benefits of solar water heaters.	BTL 1	Remembering
	PART – B		
1.	Describe thermal conduction, convection and radiation processes with suitable examples. (13)	BTL 4	Analyzing
2.	Outline various modes of heat transmission with examples. (13)	BTL 3	Applying
3.	How will you determine the thermal conductivity of a poor conductor using Lee's disc method? Give the necessary theory. (13)	BTL 3	Applying
4.	(i) Explain the terms: temperature gradient, steady state and thermal conductivity. (10) (ii) A solid square of side 50 cm and thickness 10 cm is in contact with steam at 100°C on one side. A block of ice at 0°C rests on the other side of the solid. 5 kg of ice is melted in one hour. Calculate the thermal conductivity of the solid. (3)	BTL 3 BTL 4	Applying Analyzing
5.	With a neat diagram, demonstrate a method to determine the thermal conductivity of a bad conductor. (13)	BTL 4	Analyzing
6.	Give an expression for the quantity of heat flow through a metal slab whose faces are kept at two different temperatures. Using this, determine the thermal conductivity of a bad conductor. (13)	BTL 4	Analyzing
7.	Describe Forbe's method to determine the thermal conductivity of metals with relevant theory and experiment. (13)	BTL 3	Applying
8.	Discuss the method to determining the thermal conductivity of a good conductor. (13)	BTL 4	Analyzing
9.	Derive the expression for effective heat flow through compound media in series and parallel. (13)	BTL 3	Applying
10.	(i) Discuss the heat flow through compound media in series. (10) (ii)A slab consists of two parallel layers of different materials 4 cm and 2 cm thick and of thermal conductivity 226.8 W/m/K and 150.2 W/m/K respectively. If the opposite faces of the slabs are at 100 °C and at 0 °C, calculate the temperature of the surface dividing the two. (3)	BTL 3 BTL 4	Applying Analyzing
11.	i)Drive the expression for when two bodies are connected in series with a suitable diagram. (8) (ii) Discuss the heat flow through compound media in parallel. (5)	BTL 3 BTL 4	Applying Analyzing
12.	Brief about the following (i) Thermal insulation to walls, ceilings and floors. (7) (ii) Thermal insulation to doors and windows. (6)	BTL 3	Applying
13.	With a neat diagram, discuss the different types of heat exchangers. (13)	BTL 4	Analyzing
14.	Discuss in detail (i) Parallel flow heat exchanger	BTL 4	Analyzing

	(ii) Counter flow heat exchanger (iii) Cross-flow heat exchanger (13)		
15.	Describe the working of a refrigerator. Give its applications. (13)	BTL 3	Applying
16.	Describe a type of oven which is used for the sterilization of medical instruments. (13)	BTL 4	Analyzing
17.	Describe the principle, construction and working of the solar water heater. Mention two advantages and disadvantages of it. (13)	BTL 3	Applying
PART C			
1.	Determine the thermal conductivity of a good conductor with relevant theory and experiment. (15)	BTL 4	Analyzing
2.	Explain the necessary theory and experiment to determine the thermal conductivity of a circular cardboard. (15)	BTL 3	Applying
3.	Explain the principle of heat exchangers. Describe the working and applications of heat exchangers. (15)	BTL 4	Analyzing
4.	Explain the working of any one type of oven. Mention its applications. (15)	BTL 3	Applying
5.	The boilers are made up of different layers of conducting materials. Explain the heat conduction in such an arrangement when connected in series and parallel with necessary equations. (15)	BTL 4	Analyzing
UNIT IV - QUANTUM PHYSICS			
Black body radiation – Planck's theory (derivation)- deduction of Wien's and Rayleigh jeans law – Compton effect: theory and experimental verification – wave-particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations –particle in a one-dimensional – three-dimensional potential box– tunnelling (qualitative) - scanning tunnelling microscope.			
PART – A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Define black body radiation.	BTL 1	Remembering
2.	Write any two characteristics of the black body radiation spectrum.	BTL 1	Remembering
3.	List two postulates of Planck's quantum theory of black body radiation.	BTL 1	Remembering
4.	Define Wien's displacement law.	BTL 1	Remembering
5.	State Rayleigh-Jeans law.	BTL 1	Remembering
6.	State Compton effect.	BTL 1	Remembering
7.	Write the expression for Compton shift. Why it is not observable in the visible region of the electromagnetic spectrum?	BTL 2	Understanding

8.	Find the change in wavelength of an X-ray photon when it is scattered through an angle of 90° by a free electron.	BTL 3	Applying
9.	What are matter waves?	BTL 1	Remembering
10.	Write any two characteristics of matter waves.	BTL 1	Remembering
11.	Calculate the de-Broglie wavelength (λ) of a ball of mass 0.060 kg moving with a velocity of 1 m/s.	BTL 3	Applying
12.	An electron is accelerated through a potential difference of 54 V. Calculate the de-Broglie wavelength associated with the electron.	BTL 3	Applying
13.	Calculate the de-Broglie wavelength of an electron of energy 100 eV.	BTL 3	Applying
14.	Write the physical significance of the wave function.	BTL 2	Understanding
15.	Mention any two applications of the Schrodinger wave equation.	BTL 1	Remembering
16.	Write the expression for the Schrodinger time-independent and time dependent wave equation.	BTL 2	Understanding
17.	The ground state energy cannot be zero for a free particle moving within a one-dimensional potential box. Justify.	BTL 2	Understanding
18.	Give the condition for normalization of the wave function.	BTL 2	Understanding
19.	Define Eigen values and Eigen function.	BTL 2	Understanding
20.	Calculate the minimum energy of the particle moving in one dimension in an infinitely high potential box of width 1 Å.	BTL 3	Applying
21.	Evaluate the energy of an electron confined in a box of width 2 Å for the first excited state.	BTL 3	Applying
22.	Write the expression for Eigen energy and wave function for a particle in a three-dimensional potential box.	BTL 1	Remembering
23.	Write the principle of scanning tunneling microscope.	BTL 1	Remembering
24.	Mention any two applications of quantum tunneling.	BTL 1	Remembering
	PART – B		
1.	(i) Write the postulates of Planck's quantum theory of radiation. (3) (ii) Derive Planck's radiation law. (10)	BTL 4	Analyzing
2.	Derive an equation for Planck's quantum theory of black body radiation. (13)	BTL 4	Analyzing
3.	Give the theory of the Compton effect and show that the Compton shift $d\lambda = \frac{h}{m_0 c}(1 - cos\theta)$. (13)	BTL 3	Applying
4.	Derive an expression for the change in wavelength of an X-ray photon when it collides with an electron. (13)	BTL 3	Applying

5.	(i) Explain the wave nature of electrons using G.P Thomson's experiment. (10) (ii)Find the change in wavelength of an X-ray photon, when it is scattered through an angle of 135° by a free electron. (3)	BTL4 BTL3	Analyzing Applying
6.	(i) Derive an expression for the wavelength of matter waves. (6) (ii) Illustrate, how the matter waves are experimentally verified using the G.P Thomson experiment. (7)	BTL4	Analyzing
7.	Derive an expression for the de-Broglie wavelength of matter waves in terms of (i) Energy (6) (ii) Voltage. (7)	BTL 3	Applying
8.	Obtain an expression for de-Broglie wavelength in terms of velocity and energy. (13)		
9.	(i) Derive an expression for de-Broglie wavelength. (7) (ii) Outline the physical significance of wave function. (6)	BTL 3 BTL 4	Applying Analyzing
10.	Starting with the classical wave equation associated with moving particles, formulate the time-independent wave equation. (13)	BTL4	Analyzing
11.	Derive an expression for Schrodinger's time-independent wave equation. (13)	BTL4	Analyzing
12.	Obtain time-dependent Schrodinger's wave equation for a free particle of mass m and energy E. (13)	BTL4	Analyzing
13.	Derive an expression for Schrodinger's time-dependent wave equation. (13)	BTL4	Analyzing
14.	Solve time-independent Schrodinger's wave equation for a particle trapped in a potential well and obtain Eigen functions and energy Eigen values for the particle. (13)	BTL 3	Applying
15.	Using Schrodinger's wave equation, deduce an expression for the wave function and energy of the particle confined in a one-dimensional potential box. (13)	BTL 3	Applying
16.	(i) With a neat sketch, explain the working of the Scanning Tunneling Microscope. (10) (ii) List the advantages and disadvantages of Scanning Tunneling Microscope. (3)	BTL4	Analyzing
17.	Outline the construction, working and applications of the Scanning Tunneling Microscope. (13)	BTL4	Analyzing
	PART – C		
1.	With the concepts of the quantum theory of black body radiation derive an expression for energy distribution. (15)	BTL4	Analyzing
2.	(i) Derive an expression for the change in wavelength of an X-ray photon when it collides with an electron. (10) (ii) Describe the experimental part of the Compton effect. (5)	BTL 3	Applying
3.	Deduce an expression for (i) Schrodinger's time-independent wave equation (8) (ii) Schrodinger's time-dependent wave equation. (7)	BTL 3	Applying
4.	Apply the Schrodinger wave equation for energy levels enclosed in a one-dimensional potential box of infinite height to obtain Eigenvalues and the corresponding Eigen function. (15)	BTL 3	Applying

5.	Explain the microscopic technique which uses the quantum tunneling principle to scan the samples with a focused electron beam. (15)	BTL4	Analyzing

Unit V Crystal Physics

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances- coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – growth of single crystals: solution and melt growth techniques - Importance of crystal physics.

PART A

Q.No	Questions	BT Level	Competence
1.	What are single crystalline materials?	BTL 1	Remembering
2.	Distinguish between crystalline and non-crystalline materials.	BTL 2	Understanding
3.	Differentiate primitive and non-primitive cells.	BTL 2	Understanding
4.	Define unit cell.	BTL 1	Remembering
5.	What are the lattice parameters for a unit cell?	BTL 1	Understanding
6.	Define space lattice.	BTL 1	Remembering
7.	Name the seven crystal systems.	BTL 2	Understanding
8.	Show the atomic positions in FCC and HCP crystal structures in a sketch.	BTL 2	Understanding
9.	What are Bravais lattices?	BTL 2	Understanding
10.	What are the terms used to characterize the crystals?	BTL 2	Understanding
11.	Define coordination number.	BTL 1	Remembering
12.	Define atomic radius.	BTL 1	Remembering
13.	What is atomic packing factor?	BTL 2	Understanding
14.	For a cubic system, sketch the planes with Miller Indices (100) and (111).	BTL 2	Understanding
15.	A crystal plane cut at 3a, 4b and 2c distances along the crystallographic axes. Find the Miller Indices of the plane.	BTL 3	Applying
16.	State the expression for interplanar spacing for a cubic system in terms of lattice constant and Miller indices.	BTL 2	Understanding

17.	Lead exhibits FCC structure. Each side of the unit cell is 4.95 Å. Calculate the radius of the lead atom.	BTL 3	Applying
18.	Calculate the interplanar spacing for the (101) plane in a simple cubic lattice whose lattice constant is 4.2 Å.	BTL 3	Applying
19.	How do you justify that defects in crystals are not always harmful?	BTL 2	Understanding
20.	Define crystal imperfections.	BTL 1	Remembering
21.	What are Schottky defects?	BTL 2	Understanding
22.	What are dislocations?	BTL 2	Understanding
23.	Define Burger's vector.	BTL 1	Remembering
24.	List out the different types of crystal growth techniques.	BTL 1	Remembering
	PART – B		
1.	Describe the seven crystal systems with neat diagrams. (13)	BTL 4	Analyzing
2.	Explain the No. of atoms, atomic radius, Co-ordination number and packing factor for SC and BCC structures. (13)	BTL 3	Applying
3.	Calculate the Atomic Packing Factor (APF) for SC, BCC and FCC structures. (13)	BTL 3	Applying
4.	(i) Describe BCC structure. Derive an expression for the number of atoms, co-ordination number, atomic radius and packing factor. (10) (ii) The density of copper is 8980 kg/m^3 and the unit cell dimension is 3.61 Å, the atomic weight of Cu is 63.54. Determine the crystal structure and calculate the atomic radius. (3)	BTL 2 BTL 3	Understanding Applying
5.	Describe the FCC structure and derive the number. of atoms, co-ordination number, atomic radius and packing factor. (13)	BTL 4	Analyzing
6.	Explain the HCP structure. Show that for an HCP structure $c/a = \sqrt{8}/\sqrt{3}$ and hence calculate packing fraction for HCP structure. (13)	BTL 3	Applying
7.	Show that atomic packing factor for FCC and HCP are the same. (10) Prove that for a simple cubic system $d_{100}: d_{110}: d_{111} = \sqrt{6}:\sqrt{3}:\sqrt{2}$. (3)	BTL 4 BTL 3	Analyzing Applying
8.	Determine co- ordination number and packing density for a hexagonal close-packed structure. Show that an hcp structure demands an axial ratio of 1.6333. (13)	BTL 4	Analyzing
9.	(i) Obtain the relation between Miller indices and inter-planar spacing of a cubic structure. (10) (ii) Determine lattice constant for FCC Lead crystal of radius 1.746 Å. Also, find the spacing of (2 2 0). (3)	BTL 3 BTL 3	Applying Applying
10.	Derive an expression for the inter-planar spacing for (h k l) planes of a cubic structure. (13)	BTL 2	Understanding
11.	(i) List the steps to find the miller indices of a plane. (3) (ii) Show that for a cubic lattice the distance between two successive plane (hkl) is given by $d = \frac{a}{\sqrt{(h^2+k^2+l^2)}}$. (10)	BTL 4 BTL 2	Analyzing Understanding

12.	What is meant by crystal defects? Explain the various types of crystal defects with a neat diagram. (13)	BTL 4	Analyzing
13.	Analyze about point defects and line defects with neat diagrams. (13)	BTL 4	Analyzing
14.	Explain the line defects, Burger vectors and stacking faults. (13)	BTL 2	Understanding
15.	Explain the various solution growth techniques along with their merits and demerits. (13)	BTL 4	Analyzing
16.	Describe the various crystal growth techniques. (13)	BTL 2	Understanding
17.	Explain the two melt growth techniques. (i) Czochralski's method. (7) (ii) Bridgmann technique. (6)	BTL 4 BTL 4	Analyzing Analyzing
	PART-C		
1.	Determine the number of atoms, atomic radius, co-ordination number, and packing factor for SC, BCC and FCC structures. (15)	BTL 3	Applying
2.	A zinc unit cell has a stacking sequence of AB AB AB. Deduce the c/a ratio and packing factor of zinc. (15)	BTL 3	Applying
3	Give the procedure for finding Miller indices of crystal planes and deduce a relation between inter-planar spacing and Miller indices of a cubic structure. (15)	BTL 3	Applying
4.	Illustrate the following with suitable diagrams. (i) Point defects (8) (ii) Line defects (7)	BTL 4	Analyzing
5.	With a neat diagram explain the various melt growth techniques to grow the technologically important crystals. (15)	BTL 4	Analyzing