INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING
QUESTION BANK

Course Title	**APPLIED PHYSICS**				
Course Code	AHSC09				
Program	B.Tech				
Semester	II				
Course Type	Foundation				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Surya Sharma NVSS, Associate Professor				

COURSE OBJECTIVES:
The students will try to learn:

I	Basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description..
II	Fundamental properties of semiconductors including the band gap, charge carrier concentration, doping and transport mechanisms..
III	The metrics of optoelectronic components, lasers, optical fiber communication and be able to incorporate them into systems for optimal performance..
IV	The appropriate magnetic and dielectric materials required for various engineering applications.

COURSE OUTCOMES:
After successful completion of the course, students should be able to:

CO 1	**Apply** the concepts of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.	Apply
CO 2	**Demonstrate** the classification of Solids and important aspects of semiconductors in terms of carrier concentration and Fermi level.	Understand
CO 3	**Make use of** the key concepts of semiconductors to explain the basic working mechanism of optoelectronic device characteristics of light-emitting diodes, photodetectors and solar cells.	Apply

CO 4	**Illustrate** the properties of dielectric and magnetic materials suitable for engineering applications.	Understand
CO 5	**Compare** the concepts of LASER and normal light in terms of mechanism and working principles for applications in different fields and scientific practices.	Understand
CO 6	**Explain** functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	Understand

QUESTION BANK:

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MODULE I				
QUANTUM MECHANICS				
PART-A ANALYTICAL QUESTIONS				
1	Calculate the velocity and kinetic energy of an electron having wavelength of 0.21nm.	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength.	CO1
2	Determine the de Broglie wavelength associated with a proton moving with a velocity of 1/10 of velocity of light. (Mass of proton = 1.674×10^{-27} kg).	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength.	CO1
3	Estimate the wavelength of an electron rose to a potential 15kV.	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength associated with electron.	CO1
4	Obtain de-Broglie wavelength of neutron. (Given kinetic energy of the neutron is 0.025eV mass of neutron = 1.674×10^{-27} kg).	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength.	CO1
5	Calculate the velocity and kinetic energy of an electron of wavelength $1.66 \times 10^{-10} m$.	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength.	CO1

6	Find the wavelength associated with an electron rose to a potential 1600V.	Understand	Learner to recall the Planck's and Einstein's theory and Understand about de Broglie wavelength associated with electron.	CO1
7	Calculate the energies that can be possessed by a particle of mass 8.50×10^{-31} kg which is placed in an infinite potential box of width $10^{-9}m$.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
8	Find the lowest energy of an electron confined in a square box of side 0.1 nm.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
9	Electrons are accelerated by 344 volts and are reflected from a crystal. The first reflection maximum occurs when the glancing angle is 60°. Determine the spacing of the crystal.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
10	An electron is bound in one-dimensional infinite well of width 1×10^{-10} m. Find the energy levels in the ground state and first two excited states.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1

PART-B LONG ANSWER QUESTIONS				
1	Compare a particle with a wave and discuss about dual nature of radiation.	Understand	Learner to recall the properties of particle and wave and understand the dual nature of light radiation	CO1
2	Enlist physical significance of wave function according to Schrodinger and Max – Born interpretation.	Understand	Learner to recall the characteristics of wave function and Understand Max Born and Schrodinger's interpretation of wave function.	CO1
3	Matter waves are new kind of waves. Justify this concept by discussing different properties of matter waves.	Understand	Learner to recall the concept of dual nature of material particle and Understand the behavior of matter wave.	CO1
4	Using Planck's and Einstein's theory of radiation, Show that the wavelength associated with an electron of mass 'm' and kinetic energy 'E' is given by $\frac{h}{\sqrt{2mE}}$	Understand	Learner to recall the Planck's and Einstein's theory and Understand the derivation of de Broglie wavelength.	CO1
5	Determine an expression for the wavelength associated with an electron, accelerated by a potential V.	Understand	Learner to recall the concept of de Broglie wavelength and understand the wavelength associated with electron.	CO1
6	Explain the difference between a matter wave and an electromagnetic wave.	Understand	Learner to recall the properties of matter wave and understand that matter waves are not electromagnetic waves	CO1
7	Describe Davisson Germer experiment with a neat diagram and explain how it established the proof for wave nature of electrons.	Understand	Learner to recall the concept of dual nature of material particle and Understand the proof for existence of matter wave.	CO1

8	Considering dual nature of electron, derive Schrodinger's time independent wave equation for the motion of an electron.	Understand	Learner to recall the concept of matter wave and understand the wave equation associated with matter wave.	CO1
9	Assuming that a particle of mass m is confined in a field free region between impenetrable walls in infinite height at $x = 0$ and $x = a$, show that the permitted energy levels of a particle are given by $n^2h^2/8ma^2$.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
10	Discuss the results from the eigen values, eigen functions and probability density for a particle in a one dimensional potential box of infinite height. Also sketch the figures.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
11	Show that the energies of a particle confined between two rigid walls of infinite potential are quantized.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
12	What is de-Broglie wave? Derive expression for de Broglie wavelength associated with a particle having mass m and velocity v.	Understand	Learner to recall the Planck's and Einstein's theory and Understand the derivation of de Broglie wavelength.	CO1
13	Discuss different phenomenon's that show the behavior of light radiation interacting with matter.	Understand	Learner to recall the properties of particle and wave and understand the dual nature of light radiation	CO1
14	Write major differences between classical mechanics and quantum mechanics.	Understand	Learner to recall the basics of classical mechanics and Understand to compare with quantum mechanics.	CO1

15	Differentiate between ψ and $\|\psi\|^2$.	Understand	Learner to recall the characteristics of wave function and Understand Max Born and Schrodinger's interpretation of wave function.	CO1
16	Highlight the conditions for an acceptable wave function.	Understand	Learner to recall the characteristics of wave function and Understand the dual nature of material particle.	CO1
17	Extend the one dimesional problem to 3 dimensions and hence give the equations for eigen values and eigen functions.	Apply	Learner to use the 1D particle in a box and deduce the equations in 3D	CO1
18	Why matter waves are observed for particles of atomic or nuclear size.	understand	Learner to recall the concept of dual nature of material particle and understand the behavior of matter wave.	CO1
19	Explain the concept of phase velocity and group velocity deduce a relation between them	understand	learner to recall the concept of dual nature and understand the concept of matter wave.	CO1
20	Derive the equation for energy of a particle confined in a 1-D infinite square well and explain energy quantization, zero-point energy and spatial nodes.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential.	CO1
Part - C(Short Answer Questions)				
1	Relate the dependency of wavelength of matter waves on velocity and mass of material particle.	Remember		CO1
2	Write an expression for de-Broglie wavelength in terms of momentum and kinetic energy.	Remember		CO1

3	Explain the conception of light behaving both as a particle and wave.	Understand	Learner to recall the properties of Particle and wave and understand the dual nature of light radiation	CO1, CO1
4	Justify the statement that Heisenberg's uncertainty principle is a direct consequence of dual nature of matter wave.	Understand	Learner to recall the properties of matter wave and understand uncertainty in locating position of particle behaving as wave.	CO1, CO1
5	Prove that matter waves travel with a velocity greater than velocity of light. Also justify it.	Understand	Learner to recall the Planck's and Einstein's theory and Understand how matter wave travel with velocity of light.	CO1, CO1
6	Write one dimensional time independent Schrodinger equation associated with matter wave.	Remember		CO1
7	Explain the feature of wave function which connects the particle nature and wave nature of matter wave.	Understand	Learner to recall the characteristics of wave function and Understand the dual nature of material particle.	CO1
8	Describe behavior of matter waves by giving any two of its properties.	Understand	Learner to recall the properties of particle and wave and understand the dual nature of material particle.	CO1
9	Define Phase Velocity associated with a matter wave.	Remember	Learner to recall the concept of matter wave	CO1
10	Define Group velocity associated with a matter wave.	Remember	Learner to recall the concept of matter wave	CO1
11	Write expressions for eigen function and eigen values for a particle in one dimensional square well box of infinite potential.	Remember		CO1

12	Discuss about Normalization condition as postulated by Max Born.	Apply	Learner to recall the characteristics of wave function and Understand Max Born interpretation of wave function and apply it to probability density.	CO1
13	What is the Schrödinger's interpretation of complex and not observable wave function?	Understand	Learner to recall the characteristics of wave function and Understand Schrodinger's interpretation of wave function and apply it to charge density.	CO1
14	How energy of a particle confined in a potential box is related to the width of the box.	Apply	Learner to recall the concept of matter wave and Understand quantization of energy and apply it to potential box.	CO1
15	Write about probability density of moving material particle as explained by Born and Schrodinger.	Apply	Learner to recall the characteristics of wave function, understand Max Born interpretation of wave function and apply it to probability density.	CO1
16	What is the minimum energy possessed by the particle in an infinitely deep potential well?	Apply	Learner to recall the concept of matter wave, understand quantization of energy and apply it to potential box.	CO1
17	Discuss about the nature of the walls of the box in which a particle is bound.	Apply	Learner to recall the concept of matter wave,understand quantization of energy and apply it to potential box.	CO1
18	What happens to the wavefunction associated with a particle in an infinitely deep potential well	Apply	Learner to recall the characteristics of wave function, understand Max Born interpretation of wave function and apply it to probability density.	CO1

19	What is the boundary condition for normalized wave function?	Apply	Learner to recall the characteristics of wave function, understand Max Born interpretation of wave function and apply it to probability density.	CO1
20	Define square well potential associated with a bound electron moving along one dimension.	Apply	Learner to recall the concept of matter wave, understand quantization of energy and apply it to potential box.	CO1
MODULE II				
INTRODUCTION TO SOLIDS AND SEMICONDUCTORS				
PART-A ANALYTICAL QUESTIONS				
1	Determine carrier concentration of an intrinsic semiconductor of band gap 0.7eV at 300K. [Given that the effective mass of electron = effective mass of hole = rest mass of electron].	Understand	Learner to recall about intrinsic semiconductor and Understand to find value of carrier concentration from the data given.	CO2
2	The intrinsic carrier density at room temperature in Ge is $2.37 \times 10^{19}/m^3$. If the electron and hole mobilities are 0.38 and $0.18 m^2V^{-1}s^{-1}$ respectively, calculate the resistivity.	Understand	Learner to recall about intrinsic semiconductor and Understand to find values of conductivity, mobility and position of Fermi level from the data given.	CO2
3	Obtain the temperature at which the E_F shifts by 15% from middle of forbidden gap (E_g)? Given E_g =1.2ev, effective mass of holes is 5 times that of electrons.	Understand	Learner to recall Fermi level and Understand its dependency on temperature and nature of dopants.	CO2
4	For silicon semiconductor with bandgap 1.12 eV, interpret the position of the Fermi level at 300 K if $m_e^* =$ 0.12 mo and $m_h^* =$ 0.28 mo.	Understand	Learner to recall Fermi level and Understand its dependency on temperature and nature of dopants.	CO2

5	In a Hall experiment, a current of 25 A is passed through a long foil of silver which is 0.1 mm thick and 3 cm wide. If the magnetic field of flux density 0.14 Wb/m^3 is applied perpendicular to the foil, calculate the Hall voltage developed and estimate the mobility of electrons in silver. The conductivity of silver is $6.8 \times 10^7 \Omega^{-1} m^{-1}$ and the Hall coefficient is $-8.4 \times 10^{-11} m^3/coulomb$.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find Hall voltage.	CO2
6	Simulate the Hall voltage developed across the width of the slab of a metallic slab carrying a current of 30 A is subjected to a magnetic field of 1.75T. The magnetic field is perpendicular to the plane of the slab and to the current. The thickness of the slab is 0.35 cm. The concentration of free electrons in the metal is 6.55×10^{28} $electrons/m^3$.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find Hall voltage.	CO2
7	Evaluate the value of carrier concentration, if the RH of a specimen is $3.66 \times 10^{-4} m^3 C^{-1}$.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find carrier concentration.	CO2
8	Calculate the density of charge carriers of semiconductor, given the Hall efficient is $-6.85 \times 10^{-5} m^3/Coulomb$.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find carrier concentration.	CO2

9	A silicon plate of thickness 1 mm, breadth 10 mm and length 100 mm is placed in a magnetic field of $0.5Wb/m^2$ acting perpendicular to its thickness. If 10^{-2} A current flows along its length, obtain the Hall voltage developed if the Hall coefficient is $3.66 \times 10^{-4} m^3/coulomb$.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find Hall voltage.	CO2
10	For a semiconductor, the Hall coefficient is $-3.7 \times 10^{-6} m^3/coulomb$ and electrical conductivity is $250 m^{-1}\Omega^{-1}$. Calculate the density and mobility of charge carriers.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find density and mobility of charge carriers.	CO2
PART-B LONG ANSWER QUESTIONS				
1	Summarize Bloch's theorem? Demonstrate in detail the motion of an electron in a periodic potential.	Understand	Learner to recall one dimensional crystal array and Understand variation of potential of electron with its position in lattice.	CO2
2	Using Kronig-Penny model, show that the energy spectrum of an electron contains a number of allowed energy bands separated by forbidden bands.	Understand	Learner to recall about periodic potential and Understand formation of energy bands.	CO2
3	Explain in detail the origin of energy band formation in solids that lead to the classification of materials based on conductivity.	Understand	Learner to recall about energy band diagram and Understand types of solids based on width of forbidden energy gap.	CO2
4	Distinguish between intrinsic and extrinsic semiconductors. Indicate on an energy level diagram, the conduction and valence bands, donor and acceptor levels for intrinsic and extrinsic semiconductors.	Understand	Learner to recall different semiconductors and Understand about them based on their energy levels.	CO2

5	Develop a mathematical expression for intrinsic carrier concentration and hence prove that the Fermi level lies at the middle for an intrinsic semiconductor.	Understand	Learner to recall about intrinsic semiconductor and Understand derivation of its carrier concentration and locating position of Fermi level.	CO2
6	Obtain an expression for carrier concentration of n-type semiconductor.	Understand	Learner to recall about extrinsic semiconductor and Understand derivation of carrier concentration of n-type semiconductor.	CO2
7	Derive an expression for carrier concentration of p-type semiconductor.	Understand	Learner to recall about extrinsic semiconductor and Understand derivation of carrier concentration of p-type semiconductor	CO2
8	Illustrate the dependence of Fermi level on carrier-concentration and temperature in n-type and p-type semiconductors.	Understand	Learner to recall Fermi level and Understand its dependency on temperature and nature of dopants.	CO2
9	Demonstrate in detail Hall effect and obtain an expression for Hall coefficient. List out the uses of Hall effect.	Apply	Learner to recall Hall effect and Understand about this phenomenon and apply it to find nature of charge carriers.	CO2
10	Interpret the graphical representation of Kronig-Penny model. Extend the conclusions drawn from the graph.	Understand	Learner to recall about periodic potential and Understand formation of energy bands.	CO2
11	With neat energy band diagrams, classify the materials into conductors, insulators and semiconductors.	Understand	Learner to recall about energy band diagram and Understand types of solids based on width of forbidden energy gap.	CO2
12	Derive an expression for the electron concentration in the conduction band of an intrinsic semiconductor.	Understand	Learner to recall about intrinsic semiconductor and Understand derivation of its electron concentration.	CO2
13	Infer an expression for hole concentration in the valence band of an intrinsic semiconductor.	Understand	Learner to recall about intrinsic semiconductor and Understand derivation of its electron concentration.	CO2

14	Summarize an intrinsic semiconductor? Justify why an intrinsic semiconductor behaves as an insulator at 0K. Highlight 2D representations of the crystal of Silicon at T = 0K and T >0K.	Understand	Learner to recall intrinsic semiconductor and Understand change in its conduction with temperature.	CO2
15	Discuss about an extrinsic semiconductor? Distinguish between n-type and p-type semiconductors.	Understand	Learner to recall extrinsic semiconductor and Understand change in its conduction with nature of dopants.	CO2
16	Explain the significance of Fermi energy level. Mention its position in intrinsic and extrinsic semiconductors at 0 K.	Understand	Learner to recall Fermi level and Understand its dependency on temperature and nature of dopants.	CO2
17	Develop the mathematical expression showing the variation of position of Fermi energy level in p-type semiconductor.	Understand	Learner to recall Fermi level and Understand derivation of expression for Fermi level showing its dependency on temperature and nature of dopants.	CO2
18	Derive mathematical expression showing the variation of position of Fermi energy level in n-type semiconductor.	Understand	Learner to recall Fermi level and Understand derivation of expression for Fermi level showing its dependency on temperature and nature of dopants.	CO2
19	Explain the classical free electron theory of metals. Also discuss its drawbacks.	Understand	Learner to recall classical free electron theory and Understand its postulates and drawbacks.	CO2
20	Discuss the assumptions made in quantum theory to overcome the drawbacks of free electron theory of metals.	Understand	Learner to recall quantum theory of solids and understand its postulates.	CO2

Part - C (SHORT ANSWER QUESTIONS)				
1	What do you mean by periodic potential associated with an electron moving in a one dimensional crystal lattice?	Understand	Learner to recall one dimensional crystal array and Understand variation of potential of electron with its position in lattice.	CO2
2	Explain a metallic solid and draw its band diagram to explain its electronic behavior.	Understand	Learner to recall structure of a metal and Understand free flow of electrons through it.	CO2
3	Justify that the crystalline solids are classified into conductors, semiconductors and insulators.	Understand	Learner to recall energy band diagram and Understand change in properties of solids with width of forbidden energy gap.	CO2
4	Illustrate electronic behavior of a semiconductor by drawing its band diagram.	Understand	Learner to recall structure of a semiconductor and Understand about its conductivity based on energy band diagram.	CO2
5	Outline the behavior of an insulator by sketching its band diagram.	Understand	Learner to recall structure of insulator and Understand about its conductivity based on energy band diagram.	CO2
6	Distinguish semiconductors based on variation of conductivity in terms of temperature and doping.	Understand	Learner to recall structure of a semiconductor and Understand about its conductivity based on energy band diagram and doping.	CO2
7	Explore an intrinsic semiconductor by giving an example.	Understand	Learner to recall structure of intrinsic semiconductor and Understand about its conductivity based on energy band diagram and temperature.	CO2
8	Give the expressions for carrier concentration of electrons and holes in intrinsic semiconductors.	Understand	Learner to recall conduction phenomenon in intrinsic semiconductor and Understand about its carrier concentration.	CO2

9	Write an expression for carrier concentration of electrons in n-type semiconductor.	Understand	Learner to recall conduction phenomenon in n-type semiconductor and Understand about its carrier concentration.	CO2
10	Give an expression for carrier concentration of holes in p-type semiconductor?	Understand	Learner to recall conduction phenomenon in p-type semiconductor and Understand about its carrier concentration.	CO2
11	Define Hall Effect.	Remember	Learner to recall hall effect.	CO2
12	How does the Fermi level play a significant role in semiconductor?	Understand	Learner to recall Fermi level and Understand its dependency on temperature.	CO2
13	Explain different mechanisms responsible for electrical resistance in metals.	Understand	Learner to recall nature of charge carriers in metals and Understand their behavior for different electrical resistance.	CO2
14	Explain about mean collision time and mobility associated with charge carriers in a semiconductor.	Remember	Learner to recall terms drift velocity and mobility and understand how their values change with movement of electrons and holes in a semiconductor.	CO2
15	List out the failures of quantum free electron theory of solids.	Remember		CO2
16	Enlighten about Root Mean Square velocity (RMS) and Relaxation time.	Remember		CO2
17	Write about Mean free path as given by classical free electron theory of metals.	Remember		CO2
18	Define Mean collision time as given by classical free electron theory of metals.	Remember		CO2
19	Discuss about formation of a hole in a semiconductor.	Understand	Learner to recall the concept of formation of holes and Understand its nature in a semiconductor.	CO2

20	How do you interpret the idea of conduction taking place due to movement of holes in a semiconductor?	Understand	Learner to recall the concept of formation of holes and Understand its role in conduction in a semiconductor.	CO2
MODULE III				
SEMICONDUCTOR DEVICES				
PART-A ANALYTICAL QUESTIONS				
1	Calculate the value of applied forward voltage for a p-n junction diode if $I_s = 50\mu A$, $I = 2A$ and e/kT = 40.	Understand	Learner to recall junction diode and understand calculation of applied forward voltage from the given data.	CO3
2	The current in a p-n junction at 27 °C is $0.18\mu A$ when a large reverse bias voltage is applied. Estimate the current when a forward bias of $0.98V$ is applied.	Understand	Learner to recall junction diode and understand calculation of forward current from the given data.	CO3
3	Evaluate the forward bias current of a Si diode when forward bias voltage of 0.4V is applied, the reverse saturation current is $1.17 \times 10^{-9}A$ and the thermal voltage is $25.2mV$.	Understand	Learner to recall junction diode and understand calculation of forward current from the given data.	CO3
4	Obtain the reverse saturation current of a diode if the current at 0.2V forward bias is 0.1mA at a temperature 25 °C and the ideality factor is 1.5.	Understand	Learner to recall junction diode and understand calculation of forward current from the given data.	CO3
5	Find the applied voltage on a forward biased diode if the current is 1mA and reverse saturation current is 10^{-10}. (Given temperature is 25 °C and ideality factor as 1.5).	Understand	Learner to recall junction diode and understand calculation of applied forward voltage from the given data.	CO3
6	Calculate the wavelength of emitted radiation from a LED made up of GaAs with a band gap of 1.52eV.	Apply	Learner to recall LED and understand its working principle and apply it to calculate wavelength of emitted radiation.	CO3

7	A semiconductor diode laser has a wavelength of 1.65µm. Find its band gap in eV	Apply	Learner to recall LED and understand its working principle and apply it to calculate bandgap.	CO3
8	Find the temperature at which a diode current is 2mA for a diode which has reverse saturation current of 10^{-9} A. The ideality factor is 1.4 and the applied voltage is 0.6V forward bias.	Understand	Learner to recall junction diode and understand calculation of temperature at which current is emitted.	CO3
9	Consider a silicon diode with $\eta = 1.2$. Estimate the change in voltage if the current changes from 0.1 mA to 10 mA.	Understand	Learner to recall junction diode and understand calculation of change in voltage for current variation.	CO3
10	What will be the ratio of final current to initial current of a diode if voltage of a diode changes from 0.7 V to 872.5 mV? Take ideality factor as 1.5.	Understand	Learner to recall junction diode and understand calculation of ratio of final to initial current.	CO3
PART-B LONG ANSWER QUESTIONS				
1	Write notes on direct and indirect band gap semiconductors.	Understand	Learner to recall role of energy band gap in semiconductors and understand the importance of indirect band gap semiconductors for light emission.	CO3
2	What is forward biasing of a PN junction? Draw the circuit diagram and explain.	Understand	Learner to recall biasing of diode and understand about forward biased diode behaving as conductor.	CO3
3	Describe the drift and diffusion currents in a semiconductor.	Understand	Learner to recall mobility of charge carriers in a semiconductor and understand drifting and diffusion of charge carriers contributing to current.	CO3

4	Discuss in detail about formation of a PN junction diode.	Understand	Learner to recall p-type and n-type semiconductors and understand formation PN junction diode and depletion layer in diode.	CO3
5	What is reverse biasing of a PN junction diode? Draw the circuit diagram and explain.	Understand	Learner to recall biasing of diode and understand about reverse biased diode behaving as insulator.	CO3
6	Draw the graphic symbol of crystal diode and explain its significance. How will you determine the V-I characteristics of a p-n diode.	Understand	Learner to recall junction diode and understand diode behaving as conductor and insulator from V-I characteristics.	CO3
7	Write a short note on Zener diode. Explain how Zener diode maintains constant voltage across the load.	Understand	Learner to recall Zener diode and understand how Zener diode acts as voltage regulator.	CO3
8	Draw and explain the energy band diagram for a p-n junction diode in an unbiased condition.	Understand	Learner to recall junction diode and understand change in energy band diagram of individual p-type and n-type semiconductors after forming PN junction.	CO3
9	Show that the application of forward bias voltage across p-n junction causes an exponential increase in number of charge carriers in opposite regions.	Understand	Learner to recall biasing of diode and understand about forward biased diode behaving as conductor from V-I characteristics..	CO3
10	What is Zener voltage or breakdown voltage in a PN junction diode?	Understand	Learner to recall Zener diode and understand the phenomenon of Avalanche breakdown in reverse biasing.	CO3
11	Write a note on Avalanche photo diode. Review the parameters that are commonly used to assess the performance of a detector.	Understand	Learner to recall Avalanche diode and understand difference between normal photodiode and Avalanche photodiode.	CO3

12	Illustrate the construction and working of LED. What are the advantages and disadvantages of LEDs in electronic display?	Apply	Learner to recall LED and understand its working principle and apply it in day to day life.	CO3
13	Compare and contrast the functioning of Light Emitting diode and photo diode.	Apply	Learner to recall LED and photodiode and understand difference in their working principle and application in different fields	CO3
14	Give the theory of junction photo diode with a neat diagram. Discuss the factors which limit the speed of response of photodiodes.	Apply	Learner to recall photo diode and understand its drawbacks by studying its working principle and apply it in day to day life.	CO3
15	Summarize how a photo diode can be converted into PIN and Avalanche photo diode.	Apply	Learner to recall photo diode and understand its drawbacks and apply to convert it to PIN and Avalanche photo diode.	CO3
16	In what respect is an LED different from an ordinary p-n junction diode? State applications of LEDs. Why should LEDs preferred over conventional incandescent lamps.	Apply	Learner to recall junction diode and LED and understand LED being superior to normal diode in light emission and application in day to day life.	CO3
17	Explain with a neat sketch the construction, working and V-I characteristics of solar cell.	Apply	Learner to recall solar cell and understand its construction and working principle and apply it in different fields.	CO3
18	Compare and contrast the functioning of Light Emitting diode and solar cell.	Apply	Learner to recall LED and solar cell and understand difference in their working principle and application in different fields	CO3
19	Give the properties of silicon and gallium arsenide based on band theory.	Apply	Learner to recall structure of silicon and GaAs and understand difference in their energy bandgap and apply GaAs for light emission.	CO3

20	What are the main requirements of a LED material? Infer advantages of LED.	Apply	Learner to recall LED, understand its working principle and apply it in day to day life.	CO3
PART C- SHORT ANSWER QUESTIONS				
1	Illustrate how potential barrier prevents the diffusion of electrons and holes across the junction.	Understand	Learner to recall junction diode and understand formation of depletion layer in diode.	CO3
2	Explain the terms charge carrier generation and recombination in semiconductors.	Understand	Learner to recall semiconductor and understand the phenomenon of generation and recombination of electron-hole pairs.	CO3
3	List the materials used to fabricate direct and indirect band gaps semiconductors.	Remember		CO3
4	Explain biasing of a semiconductor material. Show how they are connected in forward and reverse biasing.	Understand	Learner to recall biasing of diode and understand about forward and reverse biasing of diode.	CO3
5	List the applications of direct and indirect bandgap semiconductors.	Remember		CO3
6	Recall different techniques used for the formation PN junction diode.	Remember		CO3
7	Define Depletion layer formed in a PN junction diode. Draw the V-I characteristics of diode.	Remember		CO3
8	Draw the circuit of a forward biased PN junction diode.	Remember		CO3
9	What are elemental and compound semiconductors? Give two examples.	Understand	Learner to recall compound semiconductors and understand how they help in light emission.	CO3
10	Why is Zener diode used as voltage regulator?	Understand	Learner to recall Zener diode and understand how it behaves as voltage regulator.	CO3

11	Why do we need a suitable material for the Light Emitting Diode?	Apply	Learner to recall direct bandgap semiconductors and understand how they help in light emission.	CO3
12	Mention the different types of LED materials along with their radiant colour.	Remember		CO3
13	Illustrate any two differences between Light Emitting Diode and Photo diode.	Apply	Learner to recall LED and photo diode and understand difference in their principle.	CO3
14	Compare the principle behind working of Light Emitting Diode and solar cell.	Apply	Learner to recall LED and solar cell and understand difference in their principle.	CO3
15	Draw the circuit of a reverse biased PN junction diode	Remember		CO3
16	Mention any two advantages of Avalanche photo diode.	Remember		CO3
17	Mention the industrial applications of a solar cell.	Remember		CO3
18	What are the materials used for the fabrication of a solar cell.	Remember		CO3
19	Define efficiency of a solar cell.	Remember		CO3
20	Draw the V-I characteristics of photo diode.	Remember		CO3
MODULE IV				
ENGINEERED ELECTRIC AND MAGNETIC MATERIALS				
PART-A ANALYTICAL QUESTIONS				
1	Find the electric susceptibility of a dielectric gas having dielectric constant of 1.000041.	Apply	Learner to recall susceptibility and dielectric constant and understand relation between them and applies it to find susceptibility once given dielectric constant value.	CO4

2	A parallel capacitor has an area of $100cm^2$, a plate separation of 1 cm and is charged to a potential of 100 Volts. Calculate the capacitance of the capacitor and the change on the plates.	Apply	Learner to recall capacitor and understand capacitance in terms of area, plate separation and potential and apply it to find capacitance from the given data.	CO4
3	The dielectric constant of He gas is 1.0000684. Find the electronic polarizability of He atoms if the gas contains 2.7×10^{25} atoms per m^3.	Apply	Learner to recall polarizability and dielectric constant and understand relation between them and applies it to find polarizability once given dielectric constant value.	CO4
4	A solid dielectric with density 3×10^{28} $atoms/m^3$ shows an electronic polarizability of $10^{-40} farad - m^{-2}$. Assuming the internal electric field to be a Lorentz field, calculate the dielectric constant of the material.	Apply	Learner to recall susceptibility and dielectric constant and understand relation between them and applies it to find dielectric constant once given polarizability value.	CO4
5	A parallel capacitor of area $650mm^2$ and a plate separation of $4mm$ has a charge of $2 \times 10^{-10}C$ on it. When a material of dielectric constant 3.5 is introduced between the plates, what is the resultant voltage across the capacitors?	Apply	Learner to recall capacitor and understand capacitance in terms of area, plate separation and potential and apply it to find potential from the given data.	CO4
6	Calculate magnetization and magnetic flux density if magnetic field intensity 250 amp/m and relative permeability is 15.	Apply	Learner to recall terms related to magnetism and understands relation between them and applies it to find magnetization and flux density from the data given.	CO4

7	Find relative permeability, if $H = 220\ amp/m$ and $M = 3300 amp/m$.	Apply	Learner to recall terms related to magnetism and understands relation between them and applies it to find relative permeability from the data given.	CO4
8	The magnetic susceptibility of aluminium is 2.3×10^{-5}. Find its permeability and relative permeability.	Apply	Learner to recall terms related to magnetism and understands relation between them and applies it to find permeability from the data given.	CO4
9	If a magnetic field of strength 300 $amp/meter$ produces a magnetization of 4200 A/m in a ferromagnetic material, find the relative permeability of the material.	Apply	Learner to recall terms related to magnetism and understands relation between them and applies it to find relative permeability from the data given.	CO4
10	A paramagnetic material has a magnetic field intensity of $104 A/m$. If the susceptibility of the material at room temperature is 3.7×10^{-3}, calculate the magnetization and magnetic flux density in the material.	Apply	Learner to recall terms related to magnetism and understands relation between them and applies it to find magnetization and flux density from the data given.	CO4
PART-B LONG ANSWER QUESTIONS				
1	What do you understand by dielectric materials? Establish a relationship between D, E and P.	Understand	Learner to recall dielectric material and understand occurrence of polarization with applied electric field.	CO4
2	Explain in detail, the terms: (a). Dielectric constant (b). Electric susceptibility (c). Displacement vector	Understand	Learner to recall different terms related to polarization and understands measurement of dielectric constant, susceptibility from polarization.	CO4
3	Derive a relation between electronic polarization and electric susceptibility of the dielectric medium.	Apply	Learner to recall polarization in dielectrics and understand measurement of susceptibility and apply it to functional materials.	CO4

4	Explain in detail, the terms: (a). Polarizability (b). Polarization vector (c). Electric dipole (d). Electric dipole moment	Understand	Learner to recall different terms related to polarization and understands measurement of polarizability, dipole moment from polarization.	CO4
5	Discuss about Clausius-Mosotti relation in dielectrics subjected to static fields and also explain its significance.	Apply	Learner to recall polarizability and dielectric constant and understand relation between them and apply it to find dielectric constant once given polarizability value.	CO4
6	On application of external electric field, various polarization processes takes place in dielectric material. Explain briefly all these polarization processes.	Apply	Learner to recall different dielectric materials and understand nature of polarization occurring in it and apply it to get functional materials.	CO4
7	Obtain an expression for the internal field experienced by an atom inside a dielectric material subjected to an external field by using Lorentz method.	Apply	Learner to recall internal field and understand different types polarization contributing to it and apply it to get functional materials	CO4
8	Write notes on ferroelectricity. What are the important characteristics of ferroelectric materials	Apply	Learner to recall ferroelectric materials and understand their retention property and apply it to memory storage.	CO4
9	Explain the phenomenon of ferroelectricity with particular reference to Barium titanate.	Apply	Learner to recall structure of Barium Titanate and understand its retention property and apply it to memory storage.	CO4
10	Define dielectric breakdown. What are the different mechanisms involved in dielectric breakdown?	Apply	Learner to recall dielectric breakdown, understand causes of it and apply it to get good functional materials	CO4

11	Explain the terms magnetic dipole, magnetic dipole moment, magnetic field intensity and magnetic induction.	Understand	Learner to recall different terms related to magnetism and understands measurement of dipole moment and magnetic induction.	CO4
12	Discuss in detail about the magnetic permeability, relative permeability, Intensity of magnetization and magnetic susceptibility.	Understand	Learner to recall different terms related to magnetism and understands measurement of permeability and magnetic susceptibility.	CO4
13	Obtain a relation between magnetic susceptibility, magnetization and magnetic field intensity.	Understand	Learner to recall different terms related to magnetism and understands relation between susceptibility and magnetization.	CO4
14	Describe the origin of magnetic moment and find the magnetic dipole moments due to orbital and spin motions of an electron.	Understand	Learner to recall spins in magnetic materials and understand how magnetic moment is developed from their spins.	CO4
15	What is a Bohr magneton? How it is related to magnetic moment of electron.	Understand	Learner to recall Bohr magneton and understand how it helps to measure magnetic moment of atomic systems.	CO4
16	Distinguish between diamagnetic, paramagnetic and ferromagnetic materials. Explain their behavior with the help of examples.	Understand	Learner to recall different magnetic materials and understand their properties in terms of magnetization.	CO4
17	Illustrate the phenomenon of magnetization. Show that $B = \mu_0(H + M)$.	Understand	Learner to recall magnetization and understand derivation of relation between magnetic induction and permeability.	CO4
18	Draw the B-H curve for a ferromagnetic material and identify the retentivity and the coercive field on the curve.	Understand	Learner to recall hysteresis curve and understand to get retentivity and coercivity from it.	CO4

19	What are the sources of permanent dipole moment in magnetic materials?	understand	Learner to recall dipole moment and understand different materials exhibiting different moment values.	CO4
20	Explain the hysteresis loop in a ferromagnetic material in reference to the domain theory.	Understand	Learner to recall the domain movement in a ferro magnetic material.	CO4
PART C- SHORT QUESTIONS				
1	Explain the different types of solid dielectric materials and their polarization process.	Understand	Learner to recall different dielectric materials and understand nature of polarization occurring in it.	CO4
2	Write Lorentz relation for internal field or local field in a dielectric material.	Remember		CO4
3	How ferroelectric material is different from normal dielectric material.	Apply	Learner to recall ferroelectric materials and understand their retention property and apply it to memory storage.	CO4
4	Write the Clausius - Mosotti equation associated with a dielectric material.	Remember		CO4
5	Name different types of polarizations that occur in dielectric materials in the presence of external electric field.	Remember		CO4
6	When an electric field is applied, how does the phenomenon of polarization takes place?	Understand	Learner to recall polarization process and understand separation of charges with electric field	CO4
7	What is the difference between local electric field and applied electric field?	Understand	Learner to recall internal field and understand that internal field is greater than applied electric field.	CO4
8	Recall about polar and non-polar molecules. Give two examples for each.	Remember		CO4
9	Write the relation between electric susceptibility and dielectric constant.	Remember		CO4

10	Why is a capacitor known to be an energy storing device?	Understand	Learner to recall capacitor and understand development of charges on the surface of plates of capacitor.	CO4
11	How do you account for the magnetic properties of materials?	Understand	Learner to recall magnetic moment and understand how it helps for magnetism in some materials.	CO4
12	What is curie temperature? Is it unique for all substances?	Understand	Learner to learn curie temperature and understand transition of magnetic properties at this temperature.	CO4
13	Mention the types of magnetic materials based on electron spins.	Remember		CO4
14	Sketch neatly hysteresis loop observed in ferromagnetic materials.	Remember		CO4
15	What is hysteresis? What does the area of hysteresis curve represent?	Understand		CO4
16	Define diamagnetic, paramagnetic and ferromagnetic materials.	Remember		CO4
17	Give two examples for each diamagnetic, paramagnetic and ferromagnetic material.	Remember		CO4
18	Define coercivity and retentivity of a ferromagnetic material.	Remember		CO4
19	Discuss in detail about Bohr magneton. Also mention its value.	Understand	Learner to recall Bohr magneton and understand how it helps to measure magnetic moment of atomic systems.	CO4
20	Compare the relative permeability values of diamagnetic, paramagnetic and ferromagnetic material.	Understand	Learner to recall relative permeability and understand that ferromagnetic materials have highest relative permeability values.	CO4

MODULE V				
LASERS AND FIBER OPTICS				
PART-A ANALYTICAL QUESTIONS				
1	Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 6943 Å at 300 K.	Understand	Learner to recall expression for population and understand to calculate relative population.	CO5
2	For a He-Ne laser at 1 m and 2 m distances from the laser the output beam spot diameters are 4 mm and 6 mm respectively. Calculate the divergence.	Understand	Learner to recall divergence and understand to find its value from the data given.	CO5
3	A He-Ne laser emits light at a wavelength of 632.8 nm and has an output power of 2.3 mW. How many photons are emitted in each minute by this laser when operating?	Understand	Learner to recall energy bandgap and understand to find photons emitted from energy gap and energy of photon.	CO5
4	Solve the value of the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.44eV.	Understand	Learner to recall energy bandgap and understand to find wavelength of laser from it.	CO5
5	A semiconductor diode laser has a wavelength of 1.55µm. Estimate its band gap in eV.	Understand	Learner to recall energy bandgap and understand to find its value once given wavelength of laser.	CO5
6	A step index fiber has a numerical aperture of 0.16 and core refractive index of 1.45. Estimate the acceptance angle of the fiber and refractive index of the cladding.	Understand	Learner to recall acceptance angle and understand to find its value from the data given.	CO6

7	The refractive indices of core and cladding materials of a step index fiber are 1.48 and 1.45 respectively. Simulate i) Numerical aperture ii) Acceptance angle.	Understand	Learner to recall acceptance angle and numerical aperture and understand to find their values from the data given.	CO6
8	An optical fiber has a numerical aperture of 0.02 and a cladding refractive index of 1.59. Solve the value of acceptance angle for the fiber in water which has a refractive index of 1.33.	Understand	Learner to recall acceptance angle and understand to find its value from the data given.	CO6
9	Calculate the fractional index change for a given optical fiber if the refractive indices of the core and the cladding are 1.563 and 1.498 respectively.	Understand	Learner to recall relative refractive change and understand to find its value from the data given.	CO6
10	When the mean optical power launched into an 8 Km length of fiber is 120 µW. The mean optical power at the fiber output is 3 µW. Find the overall signal attenuation and signal attenuation per Km.	Understand	Learner to recall logarithmic formula for attenuation and understand to find its value from the data given	CO6
PART-B LONG ANSWER QUESTIONS				
1	Illustrate the characteristics of lasers, and highlight the phenomenon of lasing action required for the production of laser light.	Understand	Learner to recall characteristics of laser and understand its principle.	CO5
2	Explore the phenomena's of absorption and pumping mechanism related to excitation of atoms from lower to higher energy states?	Understand	Learner to recall transition between energy states and understand excitation to higher state with energy.	CO5

3	Demonstrate the construction and working of a Ruby laser in detail, with the help of a neat suitable diagram.	Understand	Learner to recall ruby laser and understand its construction and working.	CO5
4	Narrate the construction and working of He-Ne gaseous laser in detail, with the help of a neat diagram.	Understand	Learner to recall He-Ne laser and understand its construction and working.	CO5
5	Enlist the importance of lasers in various fields like industry, medicine, science, etc., by giving their applications.	Understand	Learner to recall characteristics of laser and understand its applications in various fields.	CO5
6	Discuss in detail the phenomenon's of spontaneous emission and stimulated emission.	Understand	Learner to recall transition between energy states and understand de-excitation to lower state.	CO5
7	What do you mean by population inversion? Explain it using three energy level diagram. Also discuss why population inversion is essential for laser action.	Understand	Learner to recall excitation process with energy and understand its role in laser emission.	CO5
8	Illustrate the purpose of an active medium and optical resonator in a laser system.	Understand	Learner to recall different parets of laser system and understand role of them in laser emission.	CO5
9	How light amplification is achieved in a laser system.	Understand	Learner to recall stimulated emission and understand role optical resonator for light amplification.	CO5
10	Explain the pumping process involved in laser emission. Also discuss in detail different pumping mechanisms.	Understand	Learner to recall excitation process and understand different ways of excitation to achieve population inversion.	CO5
11	Describe an optical fiber? Explore its construction and principle with a neat diagram.	Understand	Learner to recall optical fiber and understand its construction and principle.	CO6

12	Derive an expression for angle of acceptance of an optical fiber in terms of refractive indices of core and cladding.	Understand	Learner to recall acceptance angle and understand to get expression for it.	CO6
13	What is a Numerical aperture? Determine an expression for numerical aperture of an optical fiber.	Understand	Learner to recall Numerical Aperture and understand to get expression for it.	CO6
14	Compare different types of optical fibers based on number of modes propagation through core medium of an optical fiber.	Understand	Learner to recall single and multimode fibers and understand that single mode is best suitable for communication.	CO6
15	Draw the block diagram of fiber optic communication system and explain the functions of each block in the system.	Understand	Learner to recall different parts of optical fiber communication system and understand role of each.	CO6
16	Describe the step index fiber with a neat diagram and explain the transmission of a signal through it.	Understand	Learner to recall step index fiber and understand how its refractive index profile affects signal transmission.	CO6
17	Illustrate the advantages of optical fibers in communication system over ordinary cable communication.	Understand	Learner to recall advantages of optical fibers and understand its importance.	CO6
18	Discuss in detail graded index optical fiber with a neat figure and explain the transmission of signal through it.	Understand	Learner to recall Graded index fiber and understand how its refractive index profile reduces dispersion.	CO6
19	What do you mean by attenuation in optical fibers? Write a brief note on different losses in optical fibers.	Understand	Learner to recall transmission loss in optical fibers and understand different reasons for losses.	CO6
20	Write a note on the applications of optical fibers in different fields.	Understand	Learner to recall advantages of optical fibers and understand its application in different fields.	CO6

PART C-SHORT ANSWER QUESTIONS)				
1	Mention the three distinct processes by which a transition can take place.	Remember		CO5
2	What do you mean by coherence? Name two types of coherence.	Understand	Learner to recall coherence and understand spatial and temporal coherence.	CO5
3	State the properties of laser beam that makes it different from normal light.	Remember		CO5
4	List out the different types of lasers?	Remember		CO5
5	What is the advantage of using laser as light sources in CD player?	Understand	Learner to recall principle of laser and understand its use in CD player	CO5
6	What are the three important requisites for laser action to take place?	Remember		CO5
7	What does the term laser stand for? Illustrate about the principle of laser.	Understand	Learner to recall abbreviation of laser and understand its principle.	CO5
8	Recall the role of metastable state in achieving the population inversion.	Remember		CO5
9	Define the terms lifetime and population of an energy state.	Remember		CO5
10	List any two applications of lasers in engineering.	Remember		CO5
11	Explain the basic principle used in optical fiber for transmission of light.	Understand	Learner to recall optical fiber and understand its principle.	CO6
12	Define Acceptance angle, Acceptance cone and Numerical Aperture of an optical fiber.	Remember		CO6
13	List any two applications of optical fibers in day to day life.	Remember		CO6
14	Mention any three advantages of optical fiber communication system.	Remember		CO6

15	How is attenuation loss in optical fiber measured? Mention its units.	Understand	Learner to recall propagation of signal through fiber and understand loss during propagation.	CO6
16	Recall the expressions for Acceptance angle and Numerical aperture of an optical fiber.	Remember		CO6
17	Illustrate a neat sketch of refractive index profile of step index optical fiber.	Remember		CO6
18	State the expressions for Snell's law and critical angle associated with an optical fiber.	Remember		CO6
19	Enlist different types of attenuation in optical fibers that occur during propagation of light signals.	Remember		CO6
20	State the two different types of bending losses in an optical fiber.	Remember		CO6

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