# 0INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## COMPUTER SCIENCE AND ENGINEERING

### DEFINITIONS AND TERMINOLOGY

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| **Course Name** | : | **SEMICONDUCTOR PHYSICS** |
| **Course Code** | : | **AHSB13** |
| **Program** | : | **B.Tech** |
| **Semester** | : | **II** |
| **Branch** | : | **COMPUTER SCIENCE AND ENGINEERING** |
| **Section** | : | **D** |
| **Academic Year** | : | **2018 – 2019** |
| **Course Faculty** | : | **Mr. A Chandra Prakash. Assistant Professor.FE** |

### OBJECTIVES:

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| I | To help students to consider in depth the terminology and nomenclature used in the syllabus. |
| II | To focus on the meaning of new words / terminology/nomenclature |

### DEFINITIONS AND TERMINOLOGY QUESTION BANK

| S.No | QUESTION | ANSWER | Blooms Level | CO | CLO | CLO Code |
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| **MODULE - I** | | | | | | |
| **1** | What is quantum mechanics ? | Quantum mechanics is a theoretical science that deals with the study of the motions of the microscopic objects that have both observable wave-like and particle-like properties. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **2** | State Heisenberg's Uncertainty Principle. | It is impossible to know both the exact position and exact momentum of an object at the same time. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **3** | State Planck's Law | Planck's law or Planck's radiation law states that energy is radiated in the form of wave-packets and this energy packet has both wave and particle character. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **4** | What is a black body? | A black body is one which absorbs all wavelengths of radiation at low temperatures and emits radiation at high temperatures. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **5** | Define photoelectric effect | The emission of electrons from a metal plate when illuminated by light or any other radiation of suitable wavelength or frequency is called photoelectric effect. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **6** | Recall stopping potential. | The potential difference needed to just stop the photoelectric current is known as stopping potential. | Remember | CO 1 | CLO2 | AHSB13.02 |

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| **7** | Explain the meaning of work function of a metal. | The minimum amount of energy required to overcome the binding energy of the constituents of the metal and hence to eject an electron from the surface of the metal is known as work function of the metal. | Understand | CO 1 | CLO2 | AHSB13.02 |
| **8** | Describe Compton wavelength. | The Compton wavelength of a particle is equal to the wavelength of a photon whose energy is the same as the mass of that particle. | Understand | CO 1 | CLO2 | AHSB13.02 |
| **9** | Define Compton effect. | Compton effect is the increase in wavelength of X-rays and other electromagnetic radiations that have been elastically scattered and it is a principal way in which radiant energy is absorbed in matter. | Remember | CO 1 | CLO2 | AHSB13.02 |
| **10** | What are matter waves? | The waves associated with the particles of matter [e.g., electrons, protons etc.,] are known as matter waves or de Broglie waves. | Remember | CO 1 | CLO3 | AHSB13.03 |
| **11** | Recall phase velocity. | The velocity with which each individual wave travels is called phase velocity. | Remember | CO 1 | CLO3 | AHSB13.03 |
| **12** | Explain the term group velocity. | The velocity with which the wave packet which is formed due to the superposition of two or more waves of slighty different wavelengths is transmitted is known as group velocity. | Understand | CO 1 | CLO3 | AHSB13.03 |
| **13** | What is quantization of energy? | Quantization is the concept where energy can have only discrete values or energy is radiated in the form of discrete packets known as photons. | Remember | CO 1 | CLO3 | AHSB13.03 |
| **14** | State Bragg's law. | The Bragg's law states that when the x-ray is incident onto a crystal surface, its angle of incidence $\theta$ , will reflect back with a same angle of scattering $\theta$ and also when the path difference, d is equal to a whole number n , of wavelength, a constructive interference will occur. | Remember | CO 1 | CLO3 | AHSB13.03 |
| **15** | What is the meaning of normalization of wave function? | A normalized wave funtion means that the probability that the particle is found in the considered domain is equal to 1 and thus the integral of the square of the wave function in the domain is equal to 1. | Remember | CO 1 | CLO4 | AHSB13.04 |
| **16** | Explain the concept of particle in a one dimensional potential box. | A particle in a 1-dimensional box is a fundamental quantum mechanical approximation describing the translational motion of a single particle confined inside an infinitely deep well from which it cannot escape. | Understand | CO 1 | CLO4 | AHSB13.04 |
| **17** | Define a free particle. | A free particle is not subjected to any forces and its potential energy is constant. | Remember | CO 1 | CLO4 | AHSB13.04 |

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| **18** | What is degeneracy? | Degeneracy is the property of different quantum states having the same energy level. | Remember | CO 1 | CLO4 | AHSB13.04 |
| | **MODULE - II** | | | | | |
| **1** | State Block's theorem. | Bloch's theorem states that the wavefunction of an electron within a perfectly periodic potential may be written as where has same periodicity as potential of an electron and is called modulating function. | Remember | C0 2 | CLO 6 | AHSB13.06 |
| **2** | Describe Fermi level. | Fermi level energy is the energy level above which probability of finding an electron is 0 at 0k. i.e all the electrons have energy less than the Fermi level energy at 0k. No electron exist above Fermi level at 0k. | Understand | C0 2 | CLO 6 | AHSB13.06 |
| **3** | Recall Hall effect | The Hall effect is the production of a voltage difference (the Hall voltage) across an electrical conductor, transverse to an electric current in the conductor and to an applied magnetic field perpendicular to the current. | Remember | C0 2 | CLO 6 | AHSB13.06 |
| **4** | Define Hall coefficient. | The Hall coefficient is defined as the ratio of the induced electric field to the product of the current density and the applied magnetic field | Remember | C0 2 | CLO 6 | AHSB13.06 |
| **5** | What is an energy band? | A large number of closely spaced energy levels which are formed by merging of discrete energy levels of the individual atoms in solids is called an energy band. | Remember | C0 2 | CLO 5 | AHSB13.05 |
| **6** | What is a valence band? | The lower band which is partially or completely filled by valence electrons at T=0K is called the valence band. | Remember | C0 2 | CLO 5 | AHSB13.05 |
| **7** | Define conduction band | The lowest filled higher permitted band in which electrons move freely is called conduction band. | Remember | C0 2 | CLO 5 | AHSB13.05 |
| **8** | Recall forbidden energy gap | The energy required to transfer an electron from valence band to conduction band is called forbidden energy gap. | Remember | C0 2 | CLO 5 | AHSB13.05 |
| **9** | Explain the meaning of a conductor | Metals are conductors. There is no band gap between their valence and conduction bands, since they overlap. There is a continuous availability of electrons in these closely spaced orbitals. | Understand | C0 2 | CLO 5 | AHSB13.05 |
| **10** | What do you understand by an insulator? | In insulators, the band gap between the valence band the conduction band is so large that electrons cannot make the energy jump from the valence band to the conduction band. | Remember | C0 2 | CLO 5 | AHSB13.05 |
| **11** | Describe a semiconductor. | Semiconductors have a small energy gap between the valence band and the conduction band. Electrons can make the jump up to the conduction band, but not with the same ease as they do in conductors. | Understand | C0 2 | CLO 5 | AHSB13.05 |

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| **12** | Explain the meaning of an intrinsic semiconductor | An intrinsic semiconductor is a semiconductor in its pure state. For every electron that jumps into the conduction band, the missing electron will generate a hole that can move freely in the valence band. The number of holes will equal the number of electrons that have jumped. | Understand | C0 2 | CLO 6 | AHSB13.06 |
| **13** | What is a hole in a semiconductor? | The absence of electron in a particular place in an atom is called as hole. Hole is a electric charge carrier which has positive charge. The electric charge of hole is equal to electric charge of electron but have opposite polarity. | Remember | C0 2 | CLO 6 | AHSB13.06 |
| **14** | Describe an extrinsic semiconductor | The semiconductor in which impurities are doped to increase the electrical conductivity is called extrinsic semiconductor. | Understand | C0 2 | CLO 6 | AHSB13.06 |
| **15** | What are N-type semiconductors? | When pentavalent or donor impurity is added to an intrinsic or pure semiconductor (silicon or germanium), then it is said to be an n-type semiconductor. In n-type semiconductor, free electrons are called majority carriers and holes are called minority carriers | Remember | C0 2 | CLO 6 | AHSB13.06 |
| **16** | What are P-type semiconductors? | When trivalent or acceptor impurity is added to an intrinsic or pure semiconductor (silicon or germanium), then it is said to be an p-type semiconductor. In p-type semiconductor, holes are called majority carriers and free electrons are called minority carriers. | Remember | C0 2 | CLO6 | AHSB13.06 |
| **17** | What do you understand by generation of an electron-hole pair? | Carrier generation is a process where electron-hole pairs are created by exciting an electron from the valence band of the semiconductor to the conduction band, thereby creating a hole in the valence band. | Remember | C0 2 | CLO6 | AHSB13.06 |
| **18** | Explain the meaning of recombination of an electron-hole pair. | Recombination is the reverse process where electrons and holes from the conduction respectively valence band recombine and are annihilated | Understand | C0 2 | CLO6 | AHSB13.06 |
| **19** | Define a potential barrier. | A region in which particles are decelerated or stopped by a repulsive force is called potential barrier. | Remember | C0 2 | CLO5 | AHSB13.05 |
| | **MODULE - III** | | | | | |

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| 1 | What do you understand by generation of an electron-hole pair? | Carrier generation is a process where electron-hole pairs are created by exciting an electron from the valence band of the semiconductor to the conduction band, thereby creating a hole in the valence band | Remember | CO 3 | CLO 7 | AHSB13.07 |
| 2 | What is diode? | a semiconductor device with two terminals, typically allowing the flow of current in one direction only. | Remember | CO 3 | CLO 7 | AHSB13.07 |
| 3 | Explain the meaning of recombination of an electron-hole pair. | Recombination is the reverse process where electrons and holes from the conduction respectively valence band recombine and are annihilated | Remember | CO 3 | CLO 7 | AHSB13.07 |
| 4 | What is Photo diode? | A photodiode is a semiconductor device that converts light into an electrical current. The current is generated when photons are absorbed in the photodiode | Remember | CO 3 | CLO 8 | AHSB13.08 |
| 5 | Define LED | A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. | Remember | CO 3 | CLO 8 | AHSB13.08 |
| 6 | What is photo detector? | A photo detector has a p–n junction that converts light photons into current. | Understand | CO 3 | CLO 9 | AHSB13.08 |
| 7 | What is photo voltaic effect? | is a process that generates voltage or electric current in a photovoltaic cell when it is exposed to sunlight. | Remember | CO 3 | CLO 8 | AHSB13.08 |
| 8 | Describe Solar Cell | A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. | Remember | CO 3 | CLO 7 | AHSB13.07 |

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| 9 | What is the meaning of biasing diode | Biasing of diode means applying dc Voltage across the terminals of diode. When voltage is applied across a diode in such a way that the diode prohibits current, the | Remember | CO 3 | CLO 9 | AHSB13.08 |
| 10 | State the ohm's law | Ohm's law stating that electric current is proportional to voltage and inversely proportional to resistance. | Understand | CO 3 | CLO 9 | AHSB13.09 |
| 11 | What are direct bandgap semiconductors? | A semiconductor in which the bottom of the conduction band and the top of the valence band occur at the momentum k=0, also energy is released I the form of radiation during band-to-band electron recombination with a hole is called direct bandgap semiconductor. | Understand | CO 3 | CLO 9 | AHSB13.09 |
| 12 | What is meant by threshold voltage? | a threshold voltage refers to the voltage at which certain result occurs. Usually, it is the minimum voltage required for conduction to occur but not exclusively used to mean that. | Understand | CO 3 | CLO 9 | AHSB13.09 |
| 13 | What is the biasing in a light emitting diode | Light emitting diode is connected in forward biasing, to produce light | Understand | CO 3 | CLO 7 | AHSB13.07 |
| 14 | What is the principle behind light emitting diode. | The electron from n side recombines with the hole on p side .light is emitted due to recombination. | Understand | CO 3 | CLO 7 | AHSB13.07 |
| 15 | Explain the term diffusion in a semiconductor. | The flow of charge carriers from high density to low density is called diffusion. | Remember | CO 3 | CLO 7 | AHSB13.07 |
| 16 | Describe recombination phenomena. | The combination of an electron from conduction band to valence band is called recombination. | Understand | CO 3 | CLO 7 | AHSB13.07 |

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| 17 | What is drift velocity of an electron? | The velocity gained by an electron when an electric field is applied , is called drift velocity. | Understand | CO 3 | CLO 7 | AHSB13.07 |
| 18 | State the ohm's law | Ohm's law stating that electric current is proportional to voltage and inversely proportional to resistance. | Understand | CO 3 | CLO 9 | AHSB13.09 |
| | **MODULE - IV** | | | | | |
| 1 | Define an electric dipole. | Two equal and opposite charges separated by a distance 'r' constitute a dipole. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 2 | Describe dipole moment. | The product of charge and distance between two charges is called electric dipole moment. $\mu = q \times r$. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 3 | What is a polar dielectric ? | The dielectrics in which center of gravity of negative charge distribution does not coincide with the center of positive charge distribution are called polar dielectrics. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 4 | What is a nonpolar dielectric ? | The dielectrics in which center of gravity of negative charge distribution coincide with the center of positive charge distribution are called polar dielectrics. | Understand | CO 4 | CLO 9 | AHSB13.09 |
| 5 | Define Dielectric constant (or) Relative permittivity of the medium. | Dielectric constant is the ratio between the permittivity of the medium and the permittivity of free space. It is denoted by $\epsilon_r$. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 6 | What is electric polarization ? | When a dielectric substance is placed in an electric field, then positive and negative charges are displaced in opposite direction. This phenomena is called electric polarization. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 7 | Define the term Polarizability. | The ratio of dipole moment to that of electric field applied is called Polarizability. | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 8 | Describe Polarization Vector. | Polarization Vector is defined as the average dipole moment per MODULE volume of a dielectric. If 'N' molecules are present per MODULE volume. | Understand | CO 4 | CLO 9 | AHSB13.09 |
| 9 | Recall Electric Susceptibility. | The electric susceptibility '$\chi$' is defined as the ratio of polarization vector to the applied electric field 'E'. $\chi = P/E$ | Remember | CO 4 | CLO 9 | AHSB13.09 |
| 10 | Describe the electronic Polarization | When an electric field is applied on a dielectric material then all the positive nuclei of atoms move in the field direction and all the negative electron cloud of atoms move in opposite directions, hence dipoles are formed to | Understand | CO 4 | CLO 9 | AHSB13.09 |

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| | | produce dipole moment. | | | | |
| 11 | Define a Magnetic dipole. | Two equal and opposite poles separated by a distance 'r' constitute a dipole. | Remember | CO 4 | CLO10 | AHSB13.10 |
| 12 | What is Magnetic flux | It is defined as the amount of magnetic lines of forces passing perpendicularly through MODULE area of a given material. It is denoted by 'Φ' | Remember | CO 4 | CLO10 | AHSB13.10 |
| 13 | Recall the term Intensity of Magnetization. | The magnetic moment per MODULE volume is called Intensity of magnetization. | Remember | CO 4 | CLO10 | AHSB13.10 |
| 14 | Define Magnetic Induction | Magnetic induction at a point is defined as the force experienced by a MODULE North Pole Placed at that point. It is denoted by 'B' | Remember | CO 4 | CLO10 | AHSB13.10 |
| 15 | What is Permeability? | Permeability is the ability of the medium to pass magnetic lines of forces through it. | Remember | CO 4 | CLO10 | AHSB13.10 |
| 16 | Define Magnetic susceptibility. | Magnetic susceptibility is defined as ratio of intensity of magnetization and applied magnetic field. | Remember | CO 4 | CLO10 | AHSB13.10 |
| 17 | Define relative Permeability. | relative Permeability is defined as the ratio of Permeability of medium and Permeability of free space. | Remember | CO 4 | CLO10 | AHSB13.10 |
| | **MODULE -V** | | | | | |
| 1 | Define LASER. | LASER stands for Light Amplification by Stimulated Emission of Radiation. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 2 | Explain the phenomenon of absorption. | If a photon of energy $h\nu=E_2-E_1$ collides with an atom present in the ground state of energy $E_1$ then the atom completely absorbs the incident photon and makes transition to excited state $E_2$. This process is known as absorption. | Understand | CO 5 | CLO7 | AHSB13.07 |
| 3 | What do you mean by spontaneous emission? | An atom initially present in the excited state makes transition voluntarily on its own to the ground state, without any aid of external stimulus agency. This process is known as spontaneous emission. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 4 | Describe stimulated emission. | An atom in the excited state makes a transition to the ground state before its lifetime under the influence of external stimulus energy. This process is known as stimulated emission. | Understand | CO 5 | CLO7 | AHSB13.07 |
| 5 | What are the characteristics of a laser? | Characteristics of a laser are directionality, coherence, monochromatic and high intensity. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 6 | What are Einstein coefficients? | Einstein coefficients are mathematical quantities which are a measure of the probability of absorption or emission of light by an atom or molecule. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 7 | Define metastable state. | The excited state having long life time and whose energy level width is narrow is called metastable state. | Remember | CO 5 | CLO7 | AHSB13.07 |

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| 8 | Define population inversion. | When the population of higher excited state is more than the population of lower state, it is called population inversion. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 9 | Describe pumping. | The process of supplying suitable form of energy to a system to achieve population inversion is known as pumping. | Understand | CO 5 | CLO7 | AHSB13.07 |
| 10 | Explain optical resonator in a laser system. | Optical laser is a part of a laser, consisting of two mirrors, one highly reflective and one partially reflective, placed on either side of a laser pump and between which light bounces back and forth, enhancing stimulated emission within the pump. Light is emitted from the optical resonator through the partly reflective mirror. | Understand | CO 5 | CLO7 | AHSB13.07 |
| 11 | What do you understand by active medium? | The active medium is a collection of atoms or molecules, which can be excited into a population inversion situation, and can have electromagnetic radiation extracted out of it by stimulated emission. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 12 | What are direct bandgap semiconductors? | A semiconductor in which the bottom of the conduction band and the top of the valence band occur at the momentum k=0, also energy is released I the form of radiation during band-to-band electron recombination with a hole is called direct bandgap semiconductor. Examples are GaAs, InP, etc. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 13 | Define fiber optics. | Fiber optics, or optical fiber, refers to the medium and the technology associated with the transmission of information as light pulses along a glass or plastic strand or fiber. | Remember | CO 5 | CLO8 | AHSB13.08 |
| 14 | Explain the principle of working of an optical fiber. | Light launched into the optical fiber at one end gets propagated to the other end by total internal reflection at core-cladding interface. | Understand | CO 5 | CLO8 | AHSB13.08 |
| 15 | Recall critical angle. | Critical angle is defined as the the angle of incidence beyond which rays of light passing through a denser medium to the surface of a less dense medium are no longer refracted but totally reflected. | Remember | CO 5 | CLO8 | AHSB13.08 |
| 16 | Define acceptance angle. | Acceptance angle is the maximum angle made by the light ray with the fiber axis, so that light can propagate through the fiber after total internal reflection. | Remember | CO 5 | CLO8 | AHSB13.08 |
| 17 | What do you mean by numerical aperture? | Numerical Aperture is the light gathering capacity of an optical fiber and it is given by sine of acceptance angle. | Remember | CO 5 | CLO8 | AHSB13.08 |
| 18 | What are step index fibers? | For an optical fiber, a step-index profile is a refractive index profile characterized by a uniform refractive index within the | Understand | CO 5 | CLO8 | AHSB13.08 |

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| | | core and a sharp decrease in refractive index at the core-cladding interface so that the cladding is of a lower refractive index. | | | | |
| 19 | Explain acceptance cone. | Acceptance cone is the cone in which the light incident at acceptance angle or less than the acceptance angle and then the light can propagate through the fiber after total internal reflection. | Understand | CO 5 | CLO8 | AHSB13.08 |
| 20 | Explain the meaning of graded index fibers. | In fiber optics, a graded index is an optical fiber whose core has a refractive index that decreases with increasing radial distance from the optical axis of the fiber. | Understand | CO 5 | CLO8 | AHSB13.08 |
| 21 | Define LASER. | LASER stands for Light Amplification by Stimulated Emission of Radiation. | Remember | CO 5 | CLO7 | AHSB13.07 |
| 22 | Explain the phenomenon of absorption. | If a photon of energy $hv=E_2-E_1$ collides with an atom present in the ground state of energy $E_1$ then the atom completely absorbs the incident photon and makes transition to excited state $E_2$. This process is known as absorption. | Understand | CO 5 | CLO7 | AHSB13.07 |

**Signature of the Faculty**

**Signature of HOD**