INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**WAVES AND OPTICS**
Course Code	:	**AHSB04**
Program	:	**B.Tech**
Semester	:	**I**
Branch	:	**Mechanical Engineering**
Section	:	**A& B**
Course Faculty	:	**Dr. Koteswararao P, Associate Professor**

OBJECTIVES:

I	Enrich knowledge in principals of quantum mechanics and semiconductors.
II	Correlate principles and applications of lasers and fiber optics.
III	Meliorate the knowledge of light and optics and also their applications.
IV	Develop strong fundamentals of transverse, longitudinal waves and harmonic waves.

DEFINITIONS AND TERMINOLOGYQUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
UNIT-I QUANTUM MECHANICS						
1	What is wave Function ψ?	It is the function which gives all the information that there is about a quantum system. A quantum system can be one or many particles.	Remember	CO1	CLO2	CAHSB04.02
2	Why the de-Broglie wave associated with a moving car is notobservable?	We know that $\chi = 1/m$. Since m is very large far a car therefore χ is very small. Consequently, the de-Broglie wave associated with movingcar is not visible.	Remember	CO1	CLO2	CAHSB04.02
3	What is the rest mass of a photon? Write down relation for de-Broglie wavelength ofphoton.	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	CO1	CLO2	CAHSB04.02
4	Are matter waveselectromagnetic waves?	No. This is because electromagnetic waves are produced by accelerated charge. On the other hand, the de-Broglie wave is independent of the charge of aparticle.	Remember	CO1	CLO2	CAHSB04.02

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5	What is the difference between light waves and matterwaves?	The velocity of light waves in vacuum is a constant quantity. On the other hand, the velocity matter waves in vacuum depends upon their wavelength	Remember	CO1	CLO2	CAHSB04.02
6	Comment on the statement "Heisenberg's uncertainty principle is valid for all kinds ofparticles"	Heisenberg's uncertainty principle is valid for all kinds of particles. For the atomic particles, there is always some uncertainty in the measurement of two conjugate quantities, like position- momentum, angular position-angular momentum, energy-time etc.. but for the particles of large size, this uncertainty is very small as compared to the value of h, the Planck's constant. Hence, uncertainty is notobservable.	Remember	CO1	CLO2	CAHSB04.02
7	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	CO1	CLO2	CAHSB04.02
8	Explain about 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	CO1	CLO2	CAHSB04.02
9	Define the 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	CO1	CLO3	CAHSB04.03
10	Is light made of particles or of waves?	Light exhibits the behavior of both a particle and a wave.	Remember	CO1	CLO3	CAHSB04.03
11	What is a "system" in quantum mechanics?	A quantum system is any collection of physical objects that is to be described by a wave function.	Remember	CO1	CLO3	CAHSB04.03
12	What does the electromagnetic wave contain?	The electromagnetic wave contains both electric and magnetic fields, which are perpendicular to each other	Remember	CO1	CLO4	CAHSB04.04
13	What will be the velocity of matter wave	Matter wave can travel with more than the velocity of light	Remember	CO1	CLO4	CAHSB04.04
14	What are Standing Waves?	Two identical waves travelling towards each other interfere in such a way as to produce one wave in which there are nodes that are fixed in position. This is called a standing waves	Remember	CO1	CLO4	CAHSB04.04

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UNIT-II INTRODUCTION TO SOLIDS AND SEMICONDUCTORS						
1	What does the conductivity of metals depend upon?	The conducting property of a solid is not a function of a total number of electrons in the metal, but it is due to the number of valance electrons called free electrons.	Remember	CO2	CLO6	CAHSB04.06
2	What is the level that acts as a reference which separated the vacant and filled states at 0K?	Fermi energy level is the maximum energy level up to which the electrons can be filled at 0K. Thus it acts as reference level which separated the vacant and filled states at 0K.	Understand	CO2	CLO6	CAHSB04.06
3	Explain 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	CO2	CLO6	CAHSB04.06
4	How does a semiconductor behave at absolute zero?	A semiconductor is a solid which has the energy band similar to that of the insulator. It acts as an insulator at absolute zero.	Remember	CO2	CLO6	CAHSB04.06
5	Explain Is semiconductor acts as an insulator in the presence of impurities.	No.When the temperature is raised or when an impurity is added, their conductivity increases. Conductivity is inversely proportional to temperature.	Remember	CO2	CLO5	CAHSB04.05
6	How is the resistance of semiconductor classified?	Semiconductors have negative temperature co-efficient. The reason for this is, when the temperature is increased, a large number of charge carriers are produced due to the breaking of covalent bonds and hence these electrons move freely and gives rise to conductivity.	Remember	CO2	CLO5	CAHSB04.05
7	What are the charge carriers in semiconductors?	In conductors, electrons are charge carriers. But in semiconductors, both electrons and holes are charge carriers and will take part in conduction.	Remember	CO2	CLO5	CAHSB04.05
8	Which column elements are combined to make compound semiconductors?	The compound semiconductors are made by combining the third and fifth column elements. Such as GaAs are made by combining third and fifth column elements.	Remember	CO2	CLO5	CAHSB04.05

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9	How is charge carriers produced in extrinsic semiconductors?	Impure semiconductors in which the charge carriers are produced due to impurity atoms are called extrinsic semiconductors. They are obtained by doping an intrinsic semiconductor with impurity atoms.	Understand	CO2	CLO5	CAHSB04.05
10	What type of material is obtained when an intrinsic semiconductor is doped with pentavalent impurity?	N-type semiconductor is obtained by doping an intrinsic semiconductor with pentavalent impurity atoms.	Remember	CO2	CLO5	CAHSB04.05
11	What is Forward Biasing	A negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material	Remember	CO2	CLO5	CAHSB04.05
12	What is Reverse Biasing	A negative voltage is applied to the P-type material and a positive voltage is applied to the N-type material	Remember	CO2	CLO5	CAHSB04.05
13	What is depletion layer in	semiconductor is an insulating region within a conductive, doped semiconductor material where the mobile charge carriers have been diffused away, or have been forced away by an electric field.	Remember	CO2	CLO5	CAHSB04.05
14	Explain about potential barrier.	A region in which particles are decelerated or stopped by a repulsive force is called potential barrier.	Remember	CO2	CLO5	CAHSB04.05
UNIT-III LASERS AND FIBER OPTICS						
1	What is the need to achieve population inversion?	When population inversion is achieved, the majority of atoms are in the excited state. This causes amplification of the incident beam by stimulated emission. Thus the laser beam is produced.	Understand	CO3	CLO7	CAHSB04.07
2	Which process gives the laser its special properties as an optical source?	In Stimulated emission, the photon produced is of the same energy to the one which cause it. Hence, the light associated with stimulated photon is in phase and has same polarization. Therefore, in contrast to spontaneous emission, coherent radiation is obtained. The coherent radiation phenomenon in laser provides amplification thereby making laser a better optical source than LED.	Remember	CO3	CLO7	CAHSB04.07

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3	What type of laser could cause skin cancer if not used properly?	Eximer laser could cause skin cancer if not used properly	Understand	CO3	CLO7	CAHSB04.07
4	List the characteristics of a laser?	Characteristics of a laser are directionality, coherence, monochromatic and high intensity.	Remember	CO3	CLO7	CAHSB04.07
5	Which one is a unique property of laser?	Coherence is an important characteristic of laser beam because in laser beams, the wave trains of the same frequency are in phase/ Due to high coherence it results in an extremely high power.	Remember	CO3	CLO7	CAHSB04.07
6	Which type of laser is an example of optical pumping?	The atoms of Ruby are excited with the help of photons emitted with the help of photons emitted by an external optical source. The atoms absorb energy from photos and raises to excited state. Therefore Ruby laser is an example of optical pumping.	Remember	CO3	CLO7	CAHSB04.07
7	Define population inversion.	When the population of higher excited state is more than the population of lower state, it is called population inversion.	Remember	CO3	CLO7	CAHSB04.07
8	Explain about pumping mechanism in laser	The process of supplying suitable form of energy to a system to achieve population inversion is known as pumping.	Understand	CO3	CLO7	CAHSB04.07
9	What is the principle of fibre optical communication?.	In optical fibres, the light entering the fibre does not encounter any new surfaces, but repeatedly they hit the same surface. The reason for confining the light beam inside the fibres is the total internal reflection.	Understand	CO3	CLO7	CAHSB04.07
10	How does the refractive index vary in Graded Index fibre?	The refractive index of the core is maximum along the fibre axis and it gradually decreases. Here the refractive index varies radially from the axis of the fibre. Hence it is called graded index fibre.	Remember	CO3	CLO7	CAHSB04.07
11	Which of the following has more distortion?	When rays travel through longer distances there will be some difference in reflected angles. Hence high angle rays arrive later than low angle rays. Therefore the signal pulses are broadened thereby results in a distorted output.	Remember	CO3	CLO7	CAHSB04.07

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12	Which of the following loss occurs inside the fibre?	Scattering is a wavelength dependent loss. Since the glass used in fabrication of fibres, the disordered structure of glass will make some vibrations in the refractive index inside the fibre. This causes Rayleigh scattering.	Remember	CO3	CLO8	CAHSB04.08
13	When more than one mode is propagating, how is it dispersed?	When more than one mode is propagating through a fibre, then inter modal dispersion will occur. Since many modes are propagating, they will have different wavelengths and will take different time to propagate through the fibre.	Understand	CO3	CLO8	CAHSB04.08
14	Expiain about the 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	CO3	CLO8	CAHSB04.08
15	Define numerical aperture?	Numerical Aperture is the light gathering capacity of an optical fiber and it is given by sine of acceptance angle.	Remember	CO3	CLO8	CAHSB04.08
UNIT-IV LIGHT AND OPTICS						
1	What is an interferometer?	Interferometers work by merging two or more sources of light to create an interference pattern, which can be measured and analyzed.	Remember	CO4	CLO11	AHSB04.11
2	Explain the working of Michelson interferometer.	The Michelson interferometer produces interference fringes by splitting a beam of monochromatic light so that one beam strikes a fixed mirror and the other a movable mirror. When the reflected beams are brought back together, an interference pattern results.	Understad	CO4	CLO11	AHSB04.11
3	Describe circular aperture diffraction.	The diffraction pattern of circular disc shaped intermediate dark and bright fringes with a central bright spot, formed when light passes through a small circular aperture, is known as Circular-Aperture Diffraction.	Understand	CO4	CLO12	AHSB04.12
4	Define Airy's pattern.	The amplitude distribution for diffraction due to a circular aperture forms an	Remember	CO4	CLO12	AHSB04.12

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		intensity pattern with a bright central band surrounded by concentric circular bands of rapidly decreasing intensity is called Airy's pattern.				
5	What is Rayleigh criterion?	According to Rayleigh criterion, two images are just resolved if the centre of the first Airy pattern is superimposed on the 1st dark ring of the 2nd pattern.	Remember	CO4	CLO12	AHSB04.12
6	Define Newton's rings.	Newton's rings is a phenomenon in which an interference pattern is created by the reflection of light between two surfaces—a spherical surface and an adjacent flat surface.	Remember	CO4	CLO11	AHSB04.11
7	Give one example of Newton's rings?	Example of Newton's ring is observed in the colour full florescence on water surface with a thin layer of kerosene on it.	Remember	CO4	CLO11	AHSB04.11
8	Why is the center of Newton's ring dark?	At the center the thickness of the air film formed between lens and glass plate is zero. Therefore , at the center the geometrical path difference between the rays incident and reflected from glass plate is zero, but due to reflection a path difference of (lambda/2) is introduced. This path difference gives destructive interference at the center and hence center is dark.	Remember	CO4	CLO11	AHSB04.11
9	Explain Young's double slit experiment.	It shows that light has both a wave nature or characteristic and a particle nature or characteristic, and that these natures are inseparable. So light is said to have wave–particle duality rather than be only a wave or only a particle. The same is true of electrons and other quantum particles.	Remember	CO4	CLO11	AHSB04.11
10	Define constructive interference	When the resultant amplitude is the sum of the amplitudes due to two light waves, the interference is "constructive interference".	Remember	CO4	CLO11	AHSB04.11
11	Define destructive interference	If the resultant amplitude is equal to the difference of two amplitudes, the interference becomes "destructive interference".	Remember	CO4	CLO11	AHSB04.11

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UNIT-V HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION						
1	What do you mean by phase space?	It is a a multidimensional space in which each axis corresponds to one of the coordinates required to specify the state of a physical system, all the coordinates being thus represented so that a point in the space corresponds to a state of the system	Understand	CO5	CLO13	AHSB04.13
2	Explain about Marginal and Paraxial rays.	The parallel rays which are away from the principal axis and not meet at the principal focus after reflections are called marginal rays. AND The parallel rays near to the principal axis and after reflection meet at the principal focus are called paraxial rays	Understand	CO5	CLO13	AHSB04.13
3	Define Steradian	The SI unit of solid angle, equal to the angle at the centre of a sphere subtended by a part of the surface equal in area to the square of the radius.	Remember	CO5	CLO13	AHSB04.13
4	Recall Flux	Flux describes any effect that appears to pass or travel through a surface or substance. A flux is either a concept based in physics or used with applied mathematics	Remember	CO5	CLO13	AHSB04.13
5	What is a Wilberforce?	The oscillation alternates between an elongation of a vertical spring and the rotation of an object at the end of that spring	Remember	CO5	CLO14	AHSB04.14
6	Describe Helmholtz resonator	Helmholtz resonance or wind throb is the phenomenon of air resonance in a cavity, such as when one blows across the top of an empty bottle. The name comes from a device created in the 1850s by Hermann von Helmholtz, the Helmholtz resonator.	Understand	CO5	CLO13	AHSB04.13
7	What do you understand by FWHM?	Full width at half maximum is an expression of the extent of function given by the difference between the two extreme values of the independent variable at which the dependent variable is equal to half of its maximum value. In other words, it is the width of a spectrum curve	Understand	CO5	CLO14	AHSB04.14

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		measured between those points on the y-axis which are half the maximum amplitude.				
8	Define soliton.	A soliton is a self-reinforcing solitary wave packet that maintains its shape while it propagates at a constant velocity. Solitons are caused by a cancellation of nonlinear and dispersive effects in the medium	Remember	CO5	CLO13	AHSB04.13
9	What is a Helmholtz resonator?	Helmholtz resonance or wind throb is the phenomenon of air resonance in a cavity, such as when one blows across the top of an empty bottle. The name comes from a device created in the 1850s by Hermann von Helmholtz, the Helmholtz resonator.	Remember	CO5	CLO13	AHSB04.13
10	Define intensity of a wave.	It is defined as ratio of energy per second passing normally through a given area to the Area.	Remember	CO5	CLO13	AHSB04.13
11	Recall angular velocity.	For a point describing a circle at uniform speed, the angular velocity ω is equal to the angle θ swept out by the radius in time t divided by t . ($\omega = \theta/t$)	Remember	CO5	CLO13	AHSB04.13
12	Explain the meaning of free oscillations.	Free oscillations occur when an oscillatory system (such as a mass on a spring, or a pendulum) is displaced and released. [The frequency of the free oscillations is known as the natural frequency.]	Understand	CO5	CLO13	AHSB04.13
13	Define Period T for a point describing a circle.	It is defined as time taken for one complete circuit.	Remember	CO5	CLO13	AHSB04.13
14	Describe mechanical wave.	A type of wave that involves matter. Ocean waves are mechanical waves and also the waves produced by pulling a string. The matter itself may move in place, but, as with all types of wave motion, there is no net movement of matter—only of energy.	Understand	CO5	CLO13	AHSB04.13

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15	What do you understand by periodic motion?	A wave in which a uniform series of crests and troughs follow one after the other in regular succession. By contrast, the wave produced by applying a pulse to a stretched string does not follow regular, repeated patterns.	Understand	CO5	CLO13	AHSB04.13

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