INSTITUTE OF AERONAUTICALENGINEERING

(Autonomous)
Dundigal,Hyderabad-500043

FRESHMAN ENGINEERING

TUTORIAL QUESTION BANK

Course Name	**:**	**Modern Physics**
Course Code	**:**	**AHS008**
Class	**:**	**B. Tech II Semester**
Branch	**:**	**Common for AE / ME / CE**
Year	**:**	**2017 - 2018**
Course Coordinator	**:**	**Mr. Chandra Prakash Reddy, Assistant Professor**
Course Faculty	**:**	**Dr. A Jayanth Kumar, Professor** **Dr. Rizwana, Professor** **Ms. S Charvani, Associate Professor** **Ms. K Sowmya, Assistant Professor** **Mr. K Saibaba, Assistant Professor**

COURSE OBJECTIVES (COs):

The course should enable the students to:

I	Develop strong fundamentals of crystal structures and properties.
II	Meliorate the knowledge of theoretical and technological aspects of lasers.
III	Correlate principles with applications of the x-ray diffraction and defects in crystals.
IV	Enrich knowledge in modern engineering principles of interference and diffraction.

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the asking to do the following:

CAHS008.01	Recall the basic principles of physics and apply these conceptsof physics in solving the real-time problems.
CAHS008.02	Acquire knowledge of basic terms related to crystals, crystal systems, Bravais lattices and Miller Indices.
CAHS008.03	Discuss in detail different crystal structures and calculate their packing factors.
CAHS008.04	Describe different X-ray diffraction in research and development for the study of internal structures of materials.
CAHS008.05	Identify various types of defects in crystals and their effect on structure sensitive properties.
CAHS008.06	Understand the basic principles involved in the production of Laser light and also real-time applications of lasers.
CAHS008.07	Explain the principle involved in working of different types of laser systems.
CAHS008.08	Analyze basic laws of physics to correlate the mechanism of sensors in day to day life. Principle of sensor along with their applications.
CAHS008.09	Understand the importance of various sensors in real-time applications like measurement of pressure in aeronautics, detecting submarines in acoustics.
CAHS008.10	Recollect basic principle, construction, types and attenuation of optical fibers.

CAHS008.11	Apply properties of optical fibers in various real-time applications like measurement of pressure, temperature , displacement etc.,
CAHS008.12	Understand the importance of optical fibers in real-time communication system.
CAHS008.13	Interpret phenomenon of interference in thin films using Newton's rings experiment.
CAHS008.14	Identify difference in diffraction phenomenon due to single slit and N-slits.
CAHS008.15	Apply different laws of radiation to understand the phenomenon behind production of light.

QUESTION BANK QUESTIONS

UNIT – I			
CRSTALLOGRAPHY AND CRYSTAL STRUCTURES			
Part - A(Short Answer Questions)			
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Learning Outcomes (CLOs)**
1	Explain the terms unit cell and space lattice related to a crystal.	Understand	CAHS008.01 CAHS008.02
2	Write a note on basis and lattice parameters related to a crystal.	Understand	CAHS008.01 CAHS008.02
3	Mention the seven types of crystal systems that are formed based on different values of lattice parameters.	Remember	CAHS008.01 CAHS008.02
4	Write any two features of Miller indices representing a system of parallel planes.	Remember	CAHS008.01 CAHS008.02
5	Define the terms Atomic radius and Coordination number of a crystal structure.	Remember	CAHS008.01 CAHS008.03
6	What is packing factor? Mention the values of packing factor of SC, BCC and FCC structures.	Understand	CAHS008.01 CAHS008.03
7	State the values of coordination number and effective number of atoms for a simple cubic crystal.	Remember	CAHS008.01 CAHS008.03
8	Write the values of coordination number and effective number of atoms for a BCC structure.	Remember	CAHS008.01 CAHS008.03
9	Show that for a FCC structure, the lattice constant is given by $a = 2\sqrt{2}\, r$, where *r* is atomic radius.	Remember	CAHS008.01 CAHS008.03
10	Establish the relation between the radius and the interatomic distance for a BCC structure.	Remember	CAHS008.01 CAHS008.03
11	Sketch the planes having Miller indices (1 0 0) and (1 1 1) for a cubic crystal.	Remember	CAHS008.01 CAHS008.03
Part - B (Long Answer Questions)			
1	Describe the 3-dimensional Bravais lattices in combination with crystal systems	Understand	CAHS008.01 CAHS008.02
2	What do you understand by Miller indices of a crystal plane? Explain the method of determination of Miller indices.	Understand	CAHS008.01 CAHS008.02
3	Show that in a cubic crystal the spacing (d) between consecutive parallel planes of Miller indices (h k l) is given by $d = a / (h^2 + k^2 + l^2)^{1/2}$.	Understand	CAHS008.01 CAHS008.02
4	Sketch the planes of a cubic unit cell with the following Miller indices: (0 0 1), (1 2 0), (0 1 1) and ($\bar{2}$ 1 1).	Understand	CAHS008.01 CAHS008.02
5	Discuss the structure of simple cubic with respect to its coordination number. Also derive its packing factor.	Understand	CAHS008.01 CAHS008.03
6	Explain body centred cubic structure with a neat diagram and also	Understand	CAHS008.01

	calculate its packing factor.		CAHS008.03
7	Describe the structure of face centred cubic with respect to its coordination number, lattice constant and its packing factor	Understand	CAHS008.01 CAHS008.03
8	Show that FCC is the most closely packed out of the three cubic structures by calculating the packing factors of SC, BCC and FCC.	Understand	CAHS008.01 CAHS008.03
9	Explain the structure of Diamond with a neat diagram. Show that it is loosely packed structure by calculating its packing factor.	Understand	CAHS008.01 CAHS008.03
10	Illustrate the sodium chloride crystal structure with a neat diagram representing arrangement of ions at different lattice points.	Understand	CAHS008.01 CAHS008.03
Part - C (Analytical Questions)			
1	Find the Miller indices of a set of parallel planes which makes intercepts in the ratio 3a:4b on the x and y axes and are parallel to z-axis; a, b, c being primitive vectors of the lattice.	Remember	CAHS008.01 CAHS008.02
2	Obtain the miller indices of a plane which intercepts at a, b/2 and 3c is a simple unit cell. Draw a neat diagram showing the plane.	Remember	CAHS008.01 CAHS008.02
3	In a triclinic crystal, a lattice plane makes intercepts of lengths a, 2b and (-3c/2). Find the miller indices of the plane.	Remember	CAHS008.01 CAHS008.02
4	Show that in a simple cubic lattice the separation between the successive lattice planes (100), (110) and (111) are in the ratio of 1:0.71: 0.58	Understand	CAHS008.01 CAHS008.03
5	Copper has FCC structure and the atomic radius is 1.278A^{o}. Calculate the density of copper crystal. Given atomic weight of copper is 63.5	Understand	CAHS008.01 CAHS008.03
6	Copper has FCC structure and the atomic radius is 0.1278nm. Calculate the inter planar spacing for (111) and (321) planes	Understand	CAHS008.01 CAHS008.03
7	The distance between (110) planes in a body centred cubic structure is 0.203nm. What is the radius of the atom and size of the unit cell?	Understand	CAHS008.01 CAHS008.03
8	Copper has FCC structure and the atomic radius is 0.1278nm. Calculate the inter planar spacing for (110) and (212) planes	Understand	CAHS008.01 CAHS008.03
9	Chromium has BCC structure. Its atomic radius is 0.1249 nm. Calculate the free volume/unit cell.	Understand	CAHS008.01 CAHS008.03
UNIT – II			
X-RAY DIFFRACTION AND DEFECTS IN CRYSTALS			
Part – A (Short Answer Questions)			
1	Write the statement of Bragg's law and mention each term in the Bragg's equation.	Remember	CAHS008.04
2	Why X-rays are used for crystal diffraction studies? Mention different X-ray diffractionmethods of study of crystal structures.	Remember	CAHS008.04
3	What way the powder method is more suitable for study of crystal structures when compared with Laue method of X-ray diffraction?	Understand	CAHS008.04
4	Mention different applications of X-ray diffraction in technical field.	Understand	CAHS008.04
5	What do you understand by defect in a crystal? Give the classification chart of crystal defects.	Understand	CAHS008.05
6	Identify the significance of Burger's vector in line defects by drawing Burgers circuit for any one dislocation.	Understand	CAHS008.05
7	List out the different types of point defects that disturb regular alignment of atoms in crystal.	Understand	CAHS008.05
8	Write a short note on line defects of crystals. Mention the types of line defects that are represented as dislocations in crystals.	Remember	CAHS008.05
9	What do you understand by Frenkel defect with respect to point defects in crystals? Draw a diagram in support to your explanation.	Understand	CAHS008.05
10	DefineSchottky defect with respect to point defects in crystals. Sketch a diagram in support to your explanation.	Understand	CAHS008.05

Part - B (Long Answer Questions)			
1	State Bragg's law of X-ray diffraction. Derive the equation of Bragg's law which relates interplanar spacing and wavelength of X-rays.	Understand	CAHS008.04
2	Describe with suitable diagram, the Laue's method of determination of crystal structure. What does each spot represent in the Laue pattern?	Understand	CAHS008.04
3	Explain the principle, procedure and advantage of Debye-Scherrer method of X-ray diffraction with neat diagram.	Understand	CAHS008.04
4	What are point defects? Explain, in detail, the different types of point defects with suitable sketches.	Understand	CAHS008.05
5	Line defects can be classified into edge and screw dislocations. Discuss these dislocations with suitable diagrams.	Understand	CAHS008.05
6	What is Burger's vector? In what direction do the Burger's vectors lie with respect to i) Edge dislocation ii) Screw dislocation	Understand	CAHS008.05
Part - C (Analytical Questions)			
1	A beam of X-rays is incident on an ionic crystal with inter planar spacing 0.313 nm. Calculate wavelength of X-rays if the first order Bragg reflection takes place at a glancing angle of $7^o48'$.	Understand	CAHS008.04
2	Calculate the glancing angle at (110) plane of a cubic crystal having axial length 0.2nm corresponding to the second order diffraction maximum for the x-rays of wavelength 0.065nm.	Understand	CAHS008.04
3	X-rays of wavelength $1.5418A^o$ are diffracted by (111) planes in a crystal at an angle 30^o in the first order. Calculate the interatomic spacing.	Understand	CAHS008.04
4	A beam of X-rays of wave length 0.071nm is diffracted by (110) plane of rock salt with lattice constant of 0.28nm. Find the glancing angle for the second order diffraction.	Understand	CAHS008.04
5	Monochromatic x-rays of $\lambda=1.5A^o$ is incident on a crystal face having an interplanar spacing of $1.6A^o$. Find the highest order for which Bragg's reflection maximum can be seen.	Understand	CAHS008.04
6	Find the angle at which the third order reflection of x-rays of $0.79A^o$ wavelength can occur in a crystal of $3.04x10^{-8}$cm.	Understand	CAHS008.04
7	The Bragg's angle in the 1^{st} order for [2, 2, 0] reflection from Ni (BCC) is 38.2^o. When x-rays of wavelength $\lambda=1.54A^o$ are employed in a diffraction experiment. Determine the lattice parameter of Ni.	Understand	CAHS008.04
8	Lattice constant of copper is 0.38nm. Calculate the distance between (110) planes.	Understand	CAHS008.04
9	Calculate the glancing angle at (111) plane of a cubic crystal having axial length 0.19nm corresponding to the second order diffraction maximum for the x-rays of wavelength 0.058nm.	Understand	CAHS008.04
10	The Bragg's angle in the first order for (220) reflection from nickel (FCC) is 38.2^o, When X-ray of wavelength $1.54A^o$ are employed in a diffraction experiment. Determine the lattice parameter of a crystal.	Understand	CAHS008.04
11	When a monochromatic X-ray beam of wavelength 0.1542nm is used, the first order reflection from (101) planes occurs at θ. If the lattice parameter is 0.433nm, Find the value of θ.	Understand	CAHS008.04
UNIT-III			
LASERS AND SENSORS			
Part - A (Short Answer Questions)			
1	Define spontaneous and stimulated emission processes involved during de-excitation of atoms.	Understand	CAHS008.06

2	Explain the phenomenon of lasing action required for the production of laser light.	Understand	CAHS008.06
3	What do you understand by absorption and pumping mechanism related to excitation of atoms from lower to higher energy states?	Understand	CAHS008.06
4	Explain life time of an energy level and meta stable state related to laser system.	Understand	CAHS008.06
5	What do you understand by population inversion? How it is achieved in active medium?	Understand	CAHS008.06
6	Mention the essential characteristics of a laser beam which makes it differ from conventional light.	Remember	CAHS008.07
7	"Lasers play an important role in the field of medicine". Support this statement by listing various applications.	Remember	CAHS008.07
8	Justify that lasers are very important in industry by listing out any four applications in this field.	Understand	CAHS008.07
9	Distinguish between Ruby laser and Semiconductor diode laser by considering different aspects involved for laser emission.	Understand	CAHS008.07
10	How is light amplification achieved in a laser system by explaining the functioning of cavity resonator?	Understand	CAHS008.07
11	Mention various pumping mechanisms that are adopted in lasers for achieving population inversion.	Remember	CAHS008.07
12	What is a sensor? Mention any two sensors that are used in day today life.	Understand	CAHS008.08
13	Differentiate active and passive sensors giving examples for each type.	Understand	CAHS008.08
14	What do you understand by sensitivity and response of a sensor?	Understand	CAHS008.08
15	What is the basic principle behind bimetallic strip thermometer used for temperature sensing?	Understand	CAHS008.09
16	Give the abbreviation of SONAR. Also mention any two sensing applications of it.	Remember	CAHS008.09
17	Identify the basic principle of a photodiode that is used for optical sensing.	Understand	CAHS008.09
Part – B (Long Answer Questions)			
1	Explain the construction of a Ruby laser in detail, with the help of a neat suitable diagram.	Understand	CAHS008.07
2	What are semiconductor diode lasers? Describe the construction of a homo junction semiconductor diode laser.	Understand	CAHS008.07
3	Discuss the importance of lasers in various fields like industry, medicine , science, etc., by giving their applications.	Understand	CAHS008.07
4	Explain each characteristic of a laser light which makes it differ from ordinary light.	Remember	CAHS008.06
5	Give the differences between the spontaneous and stimulated emission processes related to production of light.	Understand	CAHS008.06
6	Explain the principle and working of a Ruby laser with relevant energy level diagram.	Understand	CAHS008.07
7	Describe the working of a homo junction semiconductor diode laser with the help of energy level diagram.	Understand	CAHS008.07
8	Discuss construction of any one temperature sensor with neat diagram. Also explain its working.	Understand	CAHS008.08
9	Explain the principle, construction and working of a pressure sensor withthe help of a suitable diagram.	Understand	CAHS008.08
10	What are the basic characteristics that should be exhibited by a sensor	Understand	CAHS008.09

	for its best performance?		
11	Describe in detail,the construction and working of fibre optic displacement sensor.	Understand	CAHS008.09
12	Explain how can we use sound waves in sensing application by discussing construction and working of any one acoustic sensor?	Understand	CAHS008.09
	Part - C (Analytical Questions)		
1	Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.44eV.	Understand	CAHS008.07
2	A semiconductor diode laser has a wavelength of 1.55μm. Find its band gap in eV.	Understand	CAHS008.07
3	Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 6943A^{o} at 300K.	Understand	CAHS008.07
4	Find the relative population of the two states in a laser that produces a light beam of wavelength 1.06 μm at 300K.	Understand	CAHS008.07
5	Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.68eV.	Understand	CAHS008.07
6	A semiconductor diode laser has a wavelength of 1.42μm. Find its band gap in eV.	Understand	CAHS008.07
7	Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 3eV.	Understand	CAHS008.07
8	The height difference between two sides of U-tube manometer is 0.5m.If the density of mercury and oil whose pressure is to be determined is 1.45 and 0.88 respectively, calculate the pressure of oil.	Understand	CAHS008.09
9	Estimate the depth of sea if the velocity of ultrasonic waves in water is 1400 m/s. Given the time interval between emitted wave and reflected wave is 6 sec.	Understand	CAHS008.09
	UNIT-IV		
	FIBER OPTICS		
	Part – A (Short Answer Questions)		
1	Write the expression for Acceptance angle and Numerical aperture of an optical fiber.	Remember	CAHS008.11
2	Draw a neat sketch ofrefractive index profile of step index optical fiber.	Remember	CAHS008.10
3	Sketch a neat diagram ofrefractive index profile of graded index optical fiber.	Remember	CAHS008.10
4	What is the principle behind propagation of light signal through an optical fiber?	Understand	CAHS008.10
5	How acceptance cone can be obtained for an optical fiber and What is its significance?	Understand	CAHS008.11
6	Distinguish between light propagation in single mode and multimode optical fibers.	Understand	CAHS008.10
7	Justify that optical fiber communication is more efficient than normal cable transmission by discussing any three advantages.	Understand	CAHS008.11
8	List different types of losses that occur during propagation of light signals in an optical fiber.	Understand	CAHS008.10
9	What do you understand by Acceptance angle of an optical fiber for the occurrence of total internal reflection?	Remember	CAHS008.11
10	Write the expressions for Snell's law and critical angle associated with an optical fiber.	Remember	CAHS008.10
	Part – B (Long Answer Questions)		
1	What is an optical fiber? Explain its construction and principle with a	Understand	CAHS008.10

	neat diagram.		
2	Derive an expression for angle of acceptance of an optical fiber in terms of refractive indices of core and cladding.	Understand	CAHS008.11
3	Define Numerical aperture. Derive an expression for numerical aperture of an optical fiber.	Understand	CAHS008.11
4	Explainin detail, different types of optical fibers based on refractive index profile of core medium.	Understand	CAHS008.10
5	Discussdifferent types of attenuation in optical fibers that occur during propagation of light signals.	Understand	CAHS008.10
6	Draw the block diagram of fiber optic communication system and explain the functions of each block in the system.	Understand	CAHS008.12
	Part - C (Analytical Questions)		
1	Calculate the refractive indices of core &cladding of an optical fiber with a numerical aperture of 0.33 and their fractional differences of refractive indices being 0.02.	Understand	CAHS008.11
2	A step index fiber has a numerical aperture of 0.16 and core refractive index of 1.45.Calculate the acceptance angle of the fiber and refractive index of the cladding.	Understand	CAHS008.11
3	The refractive indices of core and cladding materials of a step index fiber are 1.48 and 1.45 respectively. Calculate i) Numerical aperture ii) Acceptance angle.	Understand	CAHS008.11
4	An optical fiber has a numerical aperture of 0.02 and a cladding refractive index of 1.59. Find the acceptance angle for the fiber in water which has a refractive index of 1.33.	Understand	CAHS008.11
5	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	CAHS008.11
6	Calculate the numerical aperture and acceptance angle for an optical fiber with core and cladding refractive indices being 1.48 and 1.45 respectively.	Understand	CAHS008.11
	UNIT-V		
	INTERFERENCE AND DIFFRACTION		
	Part - A (Short Answer Questions)		
1	State principle of superposition of waves in case of two or more waves travelling simultaneously in a medium.	Remember	CAHS008.13
2	What is meant by interference of light? Also define constructive and destructive interference.	Understand	CAHS008.13
3	Monochromatic light from a narrow slit falls on two parallel slits and the interference fringes are obtained on a screen.Sketch this Young's double slit experiment.	Remember	CAHS008.13
4	What are coherent sources that are used for the phenomenon of interference?	Understand	CAHS008.13
5	Write the condition forconstructive and destructive interference in terms of path difference and phase difference.	Remember	CAHS008.13
6	Define fringe width.Write the expression of fringe width.	Remember	CAHS008.13
7	What do you understand by diffraction of light? Draw a neat diagram showing diffraction phenomenon.	Understand	CAHS008.14
8	Distinguish between Fraunhofer and Fresnel's classes of diffraction.	Understand	CAHS008.14
9	Compare the important phenomena's of interference and diffraction exhibited by light.	Understand	CAHS008.14
10	What is plane transmission grating? Discuss its construction.	Understand	CAHS008.14
11	Calculate the maximum number of orders possible for a plane	Understand	CAHS008.14

	diffraction grating.		
Part - B (Long Answer Questions)			
1	Give the analytical treatment of interference of light and hence obtain the condition for maximum and minimum intensity by using Young's double slit experiment.	Understand	CAHS008.13
2	Discuss in detail interference of reflected light in thin films. Find the conditions for constructive and destructive interference in thin films.	Understand	CAHS008.13
3	Derive an expression for fringe width in interference pattern and show that fringe width of both bright and dark fringes is equal.	Understand	CAHS008.13
4	Describe and explain the formation of Newton's rings in reflected light. Prove that in reflected light, (i) Diameters of the dark rings are proportional to the square roots of natural numbers and (ii) diameters of bright rings are proportional to the square roots of odd numbers.	Understand	CAHS008.13
5	How the wavelength of light and refractive index of a liquid can be determined using Newton's rings experiment.	Understand	CAHS008.13
6	Give the theory of Fraunhofer diffraction due to a single slit and hence obtain the condition for maxima and minima. Using this obtain intensity distribution curve.	Understand	CAHS008.14
7	Discuss the theory ofFraunhofer diffraction due to N slits and derive the conditions for principal maxima and minima. Using this obtain intensity distribution curve.	Understand	CAHS008.14
8	Explain experimental method of determination of wavelength of spectral lines of a given source of light using plane transmission grating.	Understand	CAHS008.14
Part - C (Analytical Questions)			
1	Two slits separated by a distance of 0.2 mm are illuminated by a monochromatic light of wavelength 550 nm. Calculate the fringe width on a screen at distance of 1 m from the slits.	Understand	CAHS008.13
2	Two coherent sources of monochromatic light of wavelength 6000 A^o produce an interference pattern on a screen kept at distance of 1 m from them. The distance between two consecutive bright fringes on the screen is 0.5 mm. Find the distance between the two coherent sources.	Understand	CAHS008.13
3	Calculate the thickness of air film at 10^{th} dark ring in a Newton's rings system viewed normally by a reflected light of wavelength 500 nm. The diameter of 10^{th} dark ring is 2 mm.	Understand	CAHS008.13
4	Find the highest order that can be seen with a grating having 15000 lines per inch. The wavelength of light used is 600 nm.	Understand	CAHS008.14
5	How many orders will be visible if the wavelength of light is 5000 A^o and the number of lines per inch on the grating is 2620?	Understand	CAHS008.14
6	A grating has 6000 lines per cm. Find the angular separation between two wavelengths 500 nm and 510 nm in the 3^{rd} order.	Understand	CAHS008.14

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