INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**Engineering Physics**				
Course Code	AHSC03				
Program	B. Tech				
Semester	I				
Course Type	Foundation				
Regulation	IARE-R20				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	1.5
Course Coordinator	Dr. B. M. Pratima, Associate Professor				

COURSE OBJECTIVES:

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 charge carrier transport mechanisms
III	Simple optical setups and experimental approaches of Light and Laser using its interaction with matter
IV	Basic comparative studies between different harmonic oscillators and different waves using such relationships on practical problems.

COURSE OUTCOMES:

At the end of the course the students should be able to:		
	Course Outcomes	**Knowledge Level (Bloom's Taxonomy)**
CO 1	**Explain**classical mechanics being replaced with a wave equation by using experiments that revealed the wave properties of matter.	Understand
CO 2	**Make use of** quantum mechanical description in Schrödinger's equation for simple systems and interpretation of wave functions.	Apply
CO 3	**Explain** the charge transport mechanism in intrinsic and extrinsic semiconductors by quantizing the charge carrier density	Understand

CO 4	**Describe** the behavior of charge carriers in a semiconductor by using the phenomenon of Hall effect.	Understand
CO 5	**Compare**the concepts of Laser and normal light in terms of mechanism and working principlesfor applications in various 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
CO 7	**Relate**the physics of interference and diffraction phenomena by using the principles of wave motion and superposition.	Remember
CO 8	**Develop** an understanding of interference and diffraction phenomenon by using different obstacles.	Apply
CO 9	**Explain**simple systems with equations of their motion and expressions of oscillation frequency by using concept of simple harmonic motion	Understand
CO 10	**Examine**different wave forms arriving at their wave equationby using necessary mathematical applications.	Apply

MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	1	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 7	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 10	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
TOTAL	22	4	-	2	-	-	-	-	-	-	-	-	15	-	-
AVERAGE	**2.2**	**0.4**	**-**	**0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.5**	**-**	**-**

TUTORIAL QUESTION BANK

MODULE-I				
QUANTUM MECHANICS				
PART – A (SHORT ANSWER QUESTIONS)				
S. No	**QUESTIONS**	**Blooms Taxonomy Level**	**How does this subsume the level below**	**Course Outcomes**
1	Relate quantum mechanics with classical mechanics	Remember	………	CO 1
2	What is Quantum mechanics and what does it explain?	Remember	………	CO 1
3	What is the de-Broglie’s hypothesis of duality of material particles and the concept of matter waves?	Remember	………	CO 1
4	Show how de-Broglie wave length is expressed in terms of momentum and kinetic energy?	Understand	Learner to recall what is de-Broglie’s wavelength, Einstein’s concept, Planck’ s law and understand how to arrive at an expression relating them	CO 1
5	Extend equation $E = h\nu$ and give the de Broglie relation for wavelength of matter wave.	Understand	Learner to recall what is de-Broglie’ s wavelength, Einstein’s concept, Planck’ s law and understand how to arrive at an expression relating them	CO 1
6	Relate the concept of Light radiation with wave-particle duality.	Understand	Learner to recall what is deBroglie’ s wavelength, Einstein’s concept, Planck’ s law and understand how to arrive at an expression relating them	CO 1
7	What are the two concepts taken into consideration to arrive at de-Broglie’s wavelength $\lambda = \frac{h}{mv}$?	Remember	………	CO 1
8	Write the different forms of de-Broglie’s wavelength of an electron.	Remember	………	CO 1
9	What is wave function? What are its applications?	Remember	………	CO2
10	Explain the Normalization condition from the physical significance of wave function	Understand	Learner to recall what is wave function and understand how to explain Normalization condition.	CO2
11	Explain the physical significance of wave function.	Understand	Learner to recall what is a wave function and understand how to explain its physical significance.	CO 1, CO 2
12	List any two properties which reveal the behavior of matter waves	Remember	……….	CO 1, CO 2

13	Write the expression for time-independent Schrodinger wave equation?	Remember	....	CO 1, CO 2
14	What is the principle used by Davisson and Germer to explain the wave nature of electron?	Remember	....	CO1
15	Explain the experimental set-up of Davisson and Germer experiment with a neat diagram	Understand	Learner to recall the principle of Davisson and Germer experiment and understand the uses of each component in the experimental set-up.	CO1
16	Summarize the observations in Davisson and Germer experiment?	Understand	Learner to recall the working and theory of Davisson and Germer experiment andunderstand the observations through the result.	CO1
17	Infer the conclusion of Davisson and Germer experiment	Understand	Learner to recall the working, theory and observations of Davisson and Germer experiment and understand the inference of the observed results.	CO1
18	What are the expressions for wave function and energy of a particle in three-dimensional square well box of infinite potential?	Remember	....	CO1, CO2
19	Explain the assumptions taken for the electron to consider it in a potential well and arrive at the eigen functions and eigen values?	Understand	Learner to recall what is a Schrodinger wave equation and understand the assumptions to be implied for the electron to be taken in a potential well.	CO2
20	What are the expressions for eigen function and eigen values for a particle in one dimensional square well box of infinite potential?	Remember	....	CO1,CO2
PART - B (LONG ANSWER QUESTIONS)				
1	What are the key points in the “introduction to Quantum mechanics”?	Remember	....	CO1
2	Quantum mechanics paved a way for better understanding of matter than Classical mechanics. Explain	Understand	Learner to recall the drawbacks of classical mechanics and understand how Quantum mechanics could fill the gap.	CO1
3	Compare a particle with a wave and discuss about dual nature of radiation	Understand	Learner to recall the properties which describe the behavior of wave and particle andcompare and arrive at dual nature of radiation.	CO1, CO2
4	Explain Max-Born interpretation (Physical significance) of wave function	Understand	Learner to recall what is wave function andunderstand how to explain its physical significance.	CO1,CO2

5	Explain how to arrive at an expression for the wavelength associated with electron, accelerated by a potential?	Understand	Learner to recall what is de Broglie' s wavelength, Einstein's concept, Planck' s law andunderstand how to arrive at an expression of wavelength in terms of applied potential.	CO1
6	Show that the expression for the wavelength associated with electron, in terms of its mass m and velocity v is $\lambda = \; h/mv$	Understand	Learner to recall what is de Broglie' s wavelength, Einstein's concept, Planck' s law and understand how to arrive at an expresion for λ relating to m and v	CO1
7	Summarize the de-Broglie's concept of matter waves	Understand	Learner to recall what is particle nature, wave nature and understand how to summarize the concept given by de Broglie for matter waves.	CO1
8	Relate different properties of matter waves and describe the concept "Matter waves are not electromagnetic waves but a new kind of waves."	Understand	Learner to recall what are the properties ofelectromagnetic waves and matter waves and understand how to relate them.	CO1
9	Show that the wavelength associated with an electron of mass *'m'* and kinetic energy *'E'* is given by $h/\sqrt{2}\, m\, E$ by making use of Planck's and Einstein's theory of radiation	Understand	Learner to recall what is de Broglie' s wavelength, Einstein's concept, Planck' s law and understand how to arrive at an expression for λ relating to E	CO1
10	Show that the wavelength associated with an electron of mass *'m'* and kinetic energy *'E'* is given by h/p by making use of Planck's Einstein's theory of radiation	Understand	Learner to recall what is de Broglie' s wavelength, Einstein's concept, Planck' s law and understand how to arrive at an expression for λ relating to p	CO1
11	Summarize the construction of Davisson &Germer experiment and explain the use of each component broadly.	Understand	Learner to recall the concept of matter waves and understand the experimental set up of Davisson & Germer experiment	CO1
12	How did Davisson &Germer in their experiment explain the proof for wave nature of electrons?	Understand	Learner to recall the concept of matter waves and understand the experimental set up of Davisson & Germer experiment	CO1
13	Show that the expression for the wave function for the wave associated with a moving particle as $\Psi(x,t) = A \exp\left[-\frac{i}{\hbar}\,(Et - px)\right]$	Understand	Learner to recall the de-Broglie's concept and energy conservation principle and arrive at an expression for the wave function.	CO2
14	Extend the concept of dual nature of electron to arrive at Schrodinger's time independent wave equation for the motion of an electron.	Understand	Learner to recall the properties which describe the behavior of wave and particle and understand how to apply the duality concept and arrive at Schrodinger wave equation.	CO2

15	Show that the permitted energy levels of a particle are given by $\frac{n^2h^2}{8m\ a^2}$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* and	Understand	Learner to recall the assumptions which describe the behavior of particle and understand how to apply the Schrodinger wave equation and arrive at an expression which quantizes the energy of the particle.	CO2
16	Interpret 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.	Understand	Learner to recall the eigen values, eigen functions and probability density for a particle in a one-dimensional potential box of infinite height and understand interpreting how they relate with one another and give the behavior of theproperties of the particle in the box.	CO2
17	Summarize the conclusions of the applications of Schrodinger's wave equation on an electron in a 1-dimensional potential well	Understand	Learner to recall the eigen values, eigen functions, probability density and wave function for a particle in a one-dimensional potential box of infinite height andunderstand summarizing the conclusions of the interpretation of results.	CO2
PART-C (Analytical Questions)				
1	Calculate the velocity and kinetic energy of an electron having wavelength of 0.21nm.	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the velocity, wavelength and energy and apply the formula to the given data	CO1
2	Find the de Broglie wavelength associated with a proton moving with a velocity of 1/10 of velocity of light. (Mass of proton = 1.674 x 10^{-27} kg).	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the velocity, wavelength and energy andapply the formula to the given data	CO1
3	Calculate the wavelength of an electron raised to a potential 15kV.	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the wavelength and applied potential andapply the formula to the given data	CO1
4	Find de-Broglie wavelength of neutron. (Given kinetic energy of the neutron is 0.025eV, mass of neutron =1.674 x 10^{-27} kg).	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the velocity,wavelength and energy andapply the formula to the given data	CO1

5	Calculate the velocity and kinetic energy of an electron of wavelength 1.66 x 10^{-10} m.	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the velocity,wavelength and energy and apply the formula to the given data	CO1
6	Find the wavelength associated with an electron rose to a potential 1600V.	Apply	Learner to recall the concept of wave particle duality, understand the relationships between the wavelength and applied potential and apply the formula to the given data	CO1
7	Calculate the energies that can be possessed by a particle of mass 8.50 x10^{-31}kg which is placed in an infinite potential box of width 10^{-9}m.	Apply	Learner to recall the concept of particle in a potential box, understand the relationships between mass of the particle, width of the well andapply the formula to the given data	CO2
8	Find the lowest energy of an electron confined in a square box of side 0.1nm.	Apply	Learner to recall the concept of particle in a potential box, understand the relationships between mass of the particle, width of the well and apply the formula to the given data	CO2
9	An electron is bound in 1-dimensional infinite well of width 1 x 10^{-10} m. Find the energy values of ground state and first two excited states	Apply	Learner to recall the concept of particle in a potential box, understand the relationships between mass of the particle, width of the well andapply the formula to the given data	CO2
10	An electron is bound in one-dimensional box of size 4x 10^{-10} m. What will be its minimum energy?	Apply	Learner to recall the concept of particle in a potential box, understand the relationships between mass of the particle, width of the well andapply the formula to the given data	CO2
MODULE-II				
INTRODUCTION TO SOLIDS AND SEMICONDUCTORS				
Part – A (Short Answer Questions)				
1	Define Bloch theorem.	Remember	………	CO3
2	Define a metallic solid and draw its band diagram to explain its electronic behavior.	Remember	………	CO3
3	Classify the crystalline solids based on the band theory.	Understand	Learner to recall the concept of band theory andunderstand the classification of solids based on band theory.	CO3

4	Define a semiconductor and draw its band diagram to explain its electronic behavior.	Remember	....	CO3
5	Define an insulator and draw its band diagram to explain its electronic behavior.	Remember	....	CO3
6	Define a conductor and draw its band diagram to explain its electronic behavior.	Remember	....	CO3
7	Explain the classification of semiconductors based on variation of conductivity in terms of temperature and doping.	Understand	Learner to recall how conductivity varies with temperature and doping and understand the classification of semiconductors based on the concept recalled.	CO3
8	Summarize your understanding of an intrinsic semiconductor? Give an example.	Understand	Learner to recall the classification ofsemiconductors andunderstand and summarize the intrinsic semiconductors.	CO3
9	Define the term ‘doping’. Why do you need to dope an intrinsic semiconductor?	Remember	....	CO3
10	What is an extrinsic semiconductor? How is it more useful than an intrinsic semiconductor?	Remember	....	CO3
11	Write the expressions for carrier concentration of electrons and holes in intrinsic semiconductors.	Remember	....	CO3
12	Write the expressions for intrinsic carrier concentration in intrinsic semiconductors	Remember	....	CO3
13	Give the expression for Fermi level in intrinsic semiconductor.	Remember	....	CO3
14	Define Fermi energy or Fermi level.	Remember	....	CO3
15	Write Fermi distribution function for electrons in metals.	Remember	....	CO3
16	Show an expression for carrier concentration of electrons in p-type semiconductor.	Understand	Learner to recall the classification of extrinsic semiconductors and understand what a p-type semiconductor is and show the expression for its carrier concentration.	CO3
17	What is an expression for carrierconcentration of holes in n-type semiconductor?	Understand	Learner to recall the classification of extrinsic semiconductors and understand what a n-type semiconductor is and show the expression for its carrier concentration.	CO3
18	Give the statement of Hall effect using a proper diagram representing current, magnetic field and Hall voltage.	Remember	....	CO4

19	Draw the diagrams showing charge carrier excitation at T = 0K and at T > 0K for n-type and p-type semiconductor.	Remember	………	CO3
20	Relate the properties of n-type and p-type semiconductors.	Understand	Learner to recall the classification of extrinsic semiconductors and understand the comparison of their properties	CO3, CO4
PART - B (LONG ANSWER QUESTIONS)				
1	Explain in detail Bloch's theorem and the motion of electron in a periodic potential.	Understand	Learner to recall the concept of wave function and understand how it can be used to describe the motion of an electron in metals using Bloch's theorem	CO3
2	Show that the energy spectrum of an electron contains a number of allowed energy bands separated by forbidden bands, using Kronig-Penny model.	Understand	Learner to recall the concept of Bloch'stheorem andunderstand how using Kronig-Penny model concludes band formation in energy spectrum of an electron	CO3
3	Explain the origin of energy band formation in solids.	Understand	Learner to recall the concept of conductivity of material using electron distribution and understand the origin of energy band formation in solids.	CO3
4	Compare the intrinsic and extrinsic semiconductors,indicating on an energy level diagram, the conduction and valence bands, donor and acceptor levels for intrinsic and extrinsic semiconductors.	Understand	Learner to recall the classification of semiconductors and understand how to distinguish them along with schematicrepresentation of levels	CO3
5	Obtain an expression for carrier concentration of n- type semiconductor.	Understand	Learner to recall the concept of band and bond picture of n-type semiconductor and understand how to obtain the expression for carrier concentration of n- type semiconductor	CO3
6	Obtain an expression for carrier concentration of p- type semiconductor.	Understand	Learner to recall the concept of band and bond picture ofp-typesemiconductor and understand how to obtain the expression for carrier concentration of p- type semiconductor	CO3
7	Find the mathematical expression for intrinsic carrier concentration and hence show that the Fermi level lies at the middle for an intrinsic semiconductor.	Understand	Learner to recall the concentration of electrons and holes in an intrinsic semiconductor and understand how to obtain the expression for intrinsic carrier concentration	CO3

8	Explain the dependence of Fermi level on carrier-concentration and temperature in extrinsic semiconductors	Understand	Learner to recall the concept of dependence of conductivity based on temperature in extrinsic semiconductor and understand how the Fermi level shifts accordingly	CO3
9	Explain in detail Hall effect and obtain an expression for Hall coefficient.	Understand	Learner to recall the concept of conductivity in extrinsic semiconductor and understand the phenomenon of Hall effect and find Hall coefficient.	CO3, CO4
10	Show the graphical representation of Kronig-Penny model. Explain the conclusions drawn from the graph.	Understand	Learner to recall the concept of Kronigg-Penney model and understand drawing conclusions from its graph.	CO3
11	Summarize the classification of materials with neat energy band diagrams.	Understand	Learner to recall the classification of materials based on their conductivity and understand summarizing the properties with energy band diagrams.	CO3
12	Derive an expression for the electron concentration in the conduction band of an intrinsic semiconductor.	Understand	Learner to recall the properties of intrinsic semiconductors and understand deriving an expression for electron concentration in the conduction band	CO3
13	Derive an expression for the hole concentration in the valence band of an intrinsic semiconductor.	Understand	Learner to recall the properties of intrinsic semiconductors andunderstand deriving an expression for holes concentration in the conduction band	CO3
14	What is an intrinsic semiconductor? Explain why an intrinsic semiconductor behaves as an insulator at 0K. Give 2D representations of the crystal of Silicon at T = 0K and T > 0K.	Understand	Learner to recall what an intrinsic semiconductoris andunderstand deriving an expression forconcentration of holes in the conduction band	CO3
15	Summarize what an extrinsic semiconductor is and distinguish between n-type and p-type semiconductors.	Understand	Learner to recall what an extrinsic semiconductor is andunderstand the distinction between n-type and p-type materials with diagrams and expressions.	CO3, CO4
16	Explain the variation of Fermi-level position with temperature in n-type semiconductor with neat diagram.	Understand	Learner to recall what an n-type semiconductor is andunderstand the variation of Fermi-level position with temperature.	CO3

17	Summarize the variation of Fermi-level position with temperature in p-type semiconductor with neat diagram.	Understand	Learner to recall what an p-type semiconductor is andunderstand the variation of Fermi-level position with temperature.	CO3
18	Explain the variation of Fermi-level position with donor concentration in n-type semiconductor with neat diagram.	Understand	Learner to recall what an n-type semiconductor is andunderstand thevariation of Fermi-level position with donor concentration.	CO3
19	Summarize the variation of Fermi-level position with acceptor concentration in p-type semiconductor with neat diagram.	Understand	Learner to recall what a p-type semiconductor is and understand the variation of Fermi-level position with donor concentration.	CO3
20	Infer the uses of Hall effect in determining various properties of a semiconductor	Understand	Learner to recall the concept of conductivity in extrinsic semiconductor andunderstand the phenomenon of Hall effect and determine various properties of a semiconductor.	CO3, CO4
Part – C (Analytical Questions)				
1	Find 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].	Apply	Learner to recall the concept of intrinsic semiconductor andapply the formula to the given data to find the intrinsic concentration.	CO3
2	What temperature would the E_F is shifted by 15% from middle of forbidden gap (E_g)? Given E_g =1.2eV, effective mass of holes is 5 times that of electrons.	Apply	Learner to recall the concept of intrinsic semiconductor andapply the formula to the given data to find theintrinsic concentration.	CO3
3	For silicon semiconductor with bandgap 1.12 eV, determine the position of the Fermi level at 300 K if $m_e^* = 0.12\ m_o$ and $m_h^* = 0.28\ m_o$.	Apply	Learner to recall the concept of intrinsic semiconductor andapply the formula to the given data to find the intrinsic concentration.	CO3
4	Calculate Hall voltage developed across the width of the slab of a metallic slab carrying a current of 30A 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 x 10^{28} electrons/m^3.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find the Hall voltage.	CO3, CO4
5	Calculate the resistivity if the intrinsic carrier density at room temperature in Ge is 2.37 x 10^{19} /m^3 and the electron and hole mobilities are 0.38 and 0.18 $m^2\ V^{-1}\ s^{-1}$ respectively.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find the Hall voltage.	CO3

6	Calculate the intrinsic charge carrier concentration for Ge at 27° C (For Ge, atomic weight =72.6, Density=5400 kg/ml, Band gap = 0.70 eV)	Apply	Learner to recall the concept of intrinsic semiconductor andapply the formula to the given data to find the intrinsic charge carrier concentration.	CO3
7	Find the conductivity of intrinsic Silicon at 300K. It is given that n_i at 300 K in silicon is 1.5 x 10^{16} /m^3 and the mobilities of electrons and holes in silicon are 0.13 m^2/V-s and 0.05 m^2/V-s respectively.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find the Hall voltage.	CO3
8	Calculate the density and mobility of charge carriers for a semiconductor, the Hall coefficient is -6.85 x 10^{-5} m^3/Coloumb, and electrical conductivity is 250 m^{-1} Ω^{-1}.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find the Hall coefficient.	CO3, CO4
9	Find μ for a specimen whose R_H is 3.66 x 10-4 m^3 C^{-1}. Its resistivity is 8.93 x 10^{-3} Ω m.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find themobility of a semiconductor.	CO3, CO4
10	Determine the conductivity of intrinsic Si at 300K if the intrinsic carrier concentration is 1.5 x 10^{16} atoms/m^3. The electron and hole mobilities in a Si sample are 0.135 and 0.048 m^2/V-s respectively.	Apply	Learner to recall the concept of Hall effect andapply the formula to the given data to find the conductivity of a semiconductor.	CO3, CO4
MODULE-III				
LASERS AND FIBER OPTICS				
Part - A (Short Answer Questions)				
1	Define spontaneous and stimulated emission processes involved during de-excitation of atoms.	Remember	....	CO5
2	Compare Stimulated emission and Absorption in a material medium exposed to light radiation	Understand	Learner to recall the concept of energy transfer due to excitation and de-excitation of electron andunderstand the comparison between the two processes.	CO5
3	Explain the phenomenon of lasing action required for the production of laser light.	Understand	Learner to recall the concept of production of laser and understand the phenomenon of lasing action used in its production.	CO5
4	Define the terms i) ‘Population’ of an energy level and ii) Population Inversion	Remember	....	CO5
5	List the most common methods of pumping to achieve population inversion.	Remember	....	CO5

6	Explain the different characteristics of laser.	Understand	Learner to remember the abbreviation of laser and understand the characteristics of laser.	CO5
7	What are the different types of lasers?	Remember	....	CO5
8	Explain the main components of laser.	Understand	Learner to recall the concept of production of laser and understand the main components of Laser used in its production.	CO5
9	Explain the following for a Ruby Laser i) Active medium ii) Pumping source and iii) Optical resonator.	Understand	Learner to recall the concept of production of Ruby laser andunderstand the given main components used in its production.	CO5
10	List the advantages and disadvantages of Ruby Laser.	Remember	....	CO5
11	What is i) Laser type ii) Active medium iii) Source of energy iv) Optical cavity v) Pumping mechanism for He-Ne Laser	Remember	....	CO5
12	List the merits and de-merits of He-Ne Laser.	Remember	....	CO5
13	List any three applications of laser beams in different fields.	Remember	....	CO5
14	What is the principle behind propagation of light signal through an optical fiber?	Remember	....	CO6
15	Relate the expression for Acceptance angle and Numerical aperture of an optical fiber.	Understand	Learner to recall the principle of working of an optical fiber andunderstand how Acceptance angle is related to Numerical Aperture.	CO6
16	Show a neat sketch of refractive index profile of step index optical fiber.	Remember	....	CO6
17	Find the expression for critical angle in an optical fiber with core refractive index as$n_1$and cladding refractive index as n_2?	Remember	....	CO6
18	Extend the principle of Snell's law and the critical angle associated with an optical fiber?	Understand	Learner to recall the principle of working of an optical fiber andunderstand how Snell's law can be applied to it.	CO6
19	List the parts which contribute to the structure of an optical fiber with a diag.	Remember	....	CO6
20	Explain different types of attenuation in optical fibers that occur during propagation of light signals.	Understand	Learner to recall the concept of attenuation in optical fibers andunderstand different types of attenuation in optical fibers that occur during propagation of light signals.	CO6

21	Define the terms (i) Acceptance angle and (ii) Numerical Aperture and (iii) Acceptance cone of an optical fiber.	Remember	....	CO6
Part – B (LONG ANSWER QUESTIONS)				
1	Explain the characteristics of lasers and the phenomenon of lasing action required for the production of laser light.	Understand	Learner to recall the concept of production of laser andunderstand the phenomenon of lasing action used in its production.	CO5
2	What do you understand by absorption and pumping mechanism related to excitation of atoms from lower to higher energy states?	Remember	....	CO5
3	Explain the following terms: i)Spontaneous emission ii) Stimulated emission iii) Pumping mechanism iv) Stimulated Absorption v) Population inversion	Understand	Learner to recall the concept of energy transfer due to excitation and de-excitation of electron andunderstand theexplanation of the phenomenon in the given terms.	CO5
4	Explain in detail how pumping mechanism is done by i) Optical pumping and ii) Electric discharge	Understand	Learner to recall the phenomenon of pumping mechanism andunderstand the different types of pumping mechanism	CO5
5	Summarize in detail the working of Laser with all its components.	Understand	Learner to recall the working principle of laser andunderstand the summary of each component in it.	CO5
6	Explain in detail three level and four level Laser pumping schemes with diagrams.	Understand	Learner to recall the phenomenon of pumping mechanism andunderstand the schemes in third and fourth level laser schemes.	CO5
7	Explain the construction of Ruby laser in detail, with the help of a neat suitable diagram.	Understand	Learner to recall different types of lasers andunderstand the detailed construction of Ruby laser	CO5
8	Summarize the construction of He-Ne gaseous laser in detail, with the help of a neat diagram.	Understand	Learner to recall different types of lasers and understand the detailed construction of He-Ne laser	CO5
9	Compare He-Ne laser and Ruby Laser with effect to their characteristics like type, active medium, pumping method and optical resonator.	Understand	Learner to recall different types of lasers and understand comparing Ruby and He-Ne laser.	CO5
10	Explain the importance of lasers in various fields like industry, medicine, science, etc., by giving their applications.	Understand	Learner to recall the working principle of laser andunderstand the how it is applicable in different streams	CO5

11	What is an optical fiber? Explain its construction and principle with a neat diagram.	Understand	Learner to recall the concept of principle of working of an optical fiber andunderstandsummarizing thecontribution of each part of it.	CO6
12	Findan expression for angle of acceptance of an optical fiber in terms of refractive indices of core and cladding	Understand	Learner to recall the principle of working of an optical fiber andunderstand how to derive an expression for Acceptance Angle	CO6
13	Explain Numerical aperture and derive an expression for numerical aperture of an optical fiber.	Understand	Learner to recall the principle of working of an optical fiber andunderstand how to derive an expression for Numerical Aperture.	CO6
14	Explain in detail, different types of optical fibers based on refractive index profile of core medium.	Understand	Learner to recall the different types of optical fibers andunderstand them with effect to refractive index profile	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 the basics in fiber optic communication system andunderstand the functions of each block in the system.	CO6
16	Explain the advantages of optical fibers in communication.	Understand	Learner to recall the communication earlier to the invention of optical fibers andunderstand the advantages of optical fibers in communication.	CO6
17	Explain in detail, different types of optical fibers based on mode propagation	Understand	Learner to recall the different types of optical fibers andunderstand them with effect to propagation modes.	CO6
18	Explain about different types attenuations in optical fibers	Understand	Learner to recall the concept of attenuation in optical fibers andunderstand the different types attenuations in optical fibers	CO6
19	Compare Step-Index and Graded-index optical fiber and write the differences between them.	Understand	Learner to recall the different types of optical fibers based on refractive index profiles and propagation modes and compare them.	CO6
20	Summarize different applications of optical fibers	Understand	Learner to recall the principle and different types of optical fibers and summarize their applications in different areas.	CO6

Part – C (Analytical Questions)				
1	Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.44eV.	Apply	Learner to recall the concept of Lasers and de-Broglie's hypothesis andapply the formula to the given data to find the wavelength of a emitted radiation.	CO5, CO1
2	A semiconductor diode laser has a wavelength of 1.55µm. Find its band gap in eV.	Apply	Learner to recall the concept of Lasers and de-Broglie's hypothesis andapply the formula to the given data to find the bandgap.	CO5, CO1
3	Calculate the wavelength of emitted radiation from a semiconductor diode laser, which has a band gap of 1.68eV.	Apply	Learner to recall the concept of Lasers and de-Broglie's hypothesis andapply the formula to the given data to find the bandgap.	CO5, CO1
4	A semiconductor diode laser has a wavelength of 1.42µm. Find its band gap in eV.	Apply	Learner to recall the concept of Lasers and de-Broglie's hypothesis andapply the formula to the given data to find the bandgap.	CO5, CO1
5	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.	Apply	Learner to recall the concept of Numerical Aperture in optical fiber andapply the formula to the given data to find the refractive index of core and cladding.	CO6
6	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.	Apply	Learner to recall the concept of Numerical Aperture and Acceptance angle in an optical fiber andapply the formula to the given data to find the refractive index of cladding and acceptance angle.	CO6
7	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.	Apply	Learner to recall the concept of Numerical Aperture and Acceptance angle in an optical fiber andapply the formula to the given data to find the N.A. and acceptance angle.	CO6
8	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.	Apply	Learner to recall the concept of Numerical Aperture and Acceptance angle in an optical fiber andapply the formula to the given data to find the acceptance angle.	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.	Apply	Learner to recall the concept of refractive indices in an optical fiber andapply the formula to the given data to find fractional index change for a given optical fiber.	CO6
MODULE-IV				
LIGHT AND OPTICS				
Part – A (Short Answer Questions)				
1	Explain the principle of superposition of waves in case of two or more waves travelling simultaneously in a medium?	Remember	....	CO7
2	What is the concept of interference of light and different types of this phenomenon	Remember	....	CO7
3	How did Young explain the formation of fringes in his experiment?	Understand	Learner to recall the Young's experiment andunderstand the formation of fringes in the experiment	CO7, CO8
4	Monochromatic light from a narrow-slit fall on two parallel slits and the interference fringes are obtained on a screen. Show this experiment with a sketch	Remember	....	CO7, CO8
5	What are coherent sources that are used for the phenomenon of interference?	Remember	....	CO7
6	Show the condition for constructive and destructive interference in terms of path difference and phase difference	Remember	....	CO7
7	Define fringe width. Write the expression of fringe width.	Remember	....	CO7
8	Write the expression for distance between two i) consecutive maxima and ii) two consecutive maxima in Youngs experiment.	Remember	....	CO7, CO8
9	Outline the conditions to maintain a permanent and stationary interference pattern.	Understand	Learner to recall the Young's experiment andunderstand the conditions to maintain a permanent and stationary interference pattern	CO7, CO8
10	What do you understand by diffraction of light? Draw a neat diagram showing diffraction phenomenon.	Remember	....	CO7, CO8
11	Explain in brief the formation of Newton rings in two sentences.	Understand	Learner to recall the concept in Newton ringsexperiment andunderstand the formation of rings.	CO7, CO8

12	Explain the function of the 45° inclined glass plate and why Newton rings are circular in shape.	Understand	Learner to recall the concept in Newton rings experiment andunderstand the reason for shape of rings and the usage of inclined glass plate.	CO7, CO8
13	Give the expression for diameter of dark ring and bright ring.	Remember	....	CO7, CO8
14	Explain why the center of the ring is dark.	Understand	Learner to recall the concept in Newton rings experiment andunderstand the reason for shape of rings and the usage of inclined glass plate.	CO7, CO8
15	Distinguish between Fraunhofer and Fresnel's classes of diffraction	Understand	Learner to recall the concept of different types of diffraction andunderstandthe comparison betweenthem.	CO7, CO8
16	Compare the important phenomena of interference and diffraction exhibited by light.	Understand	Learner to recall the concept of interference and diffraction andunderstand the comparison between them.	CO7, CO8
17	Discuss the construction of diffraction at single slit.	Understand	Learner to recall the concept of diffraction andunderstand the diffraction at single slit.	CO7, CO8
18	Discuss the construction of diffraction at double slit.	Understand	Learner to recall the concept of diffraction andunderstand the diffraction at double slit.	CO7, CO8
19	What is plane transmission grating? Discuss its construction	Remember	....	CO7, CO8
20	How does the diffraction pattern due to transmission grating look like when a white light is used?	Remember	....	CO7, CO8
Part – B (LONG ANSWER QUESTIONS)				
1	State principle of superposition of waves in case of two or more waves travelling simultaneously in a medium.	Understand	Learner to recall the principle of superposition of waves and understand applying it on two or more waves.	CO7
2	Monochromatic light from a narrow-slit fall on two parallel slits and the interference fringes are obtained on a screen. Sketch and explain this Young's double slit experiment	Understand	Learner to recall the principle of interference andunderstand the Young' s experiment using the principle.	CO7, CO8
3	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	Learner to recall the principle of interference andunderstand the Young' s experiment using the principle.	CO7, CO8

4	Findan expression for fringe width in interference pattern and show that fringe width of both bright and dark fringes is equal.	Understand	Learner to recall the principle of interference andunderstand the Young's experiment using the principle.	CO7, CO8
6	Explain how the intensity and amplitude of waves lead to constructive and destructive interference in Young's experiment	Understand	Learner to recall the concept of interference in Young' s experiment andunderstand how interference is related to intensity and amplitude.	CO7, CO8
7	Explain how the energy distribution looks like in Young' s experiment taking the help of analytical treatment	Understand	Learner to recall the concept of interference in Young' s experiment andunderstand how interference is related to intensity and amplitude.	CO7, CO8
8	Summarize the conditions to observe sustained interference and to observe good contrast in the interreference pattern	Understand	Learner to recall the concept of interference in Young' s experiment andunderstand the conditions for quality in interference pattern.	CO7
9	Describe the experimental arrangement and formation of Newton's rings.	Understand	Learner to recall the concept of interference andunderstand the experimental arrangement and formation of Newton's rings	CO7, CO8
10	Discuss the theory in the Newton's rings by reflected light and arrive at the expression for diameter of dark and bright rings.	Understand	Learner to recall the concept of interference andunderstand the experimental arrangement and formation of Newton's rings	CO7, CO8
11	Expalin how Newton rings experiment b can e useful to determine the wavelength of the monochromatic light source used?	Understand	Learner to recall the principle of Newton's rings and understand theexperimental arrangement and formation of Newton's rings	CO7, CO8
12	Extend your understanding of Newton rings experiment to determine the refractive index of any given liquid.	Understand	Learner to recall theexperiment of Newton's rings andunderstand how to determine the refractive index of any given liquid.	CO7, CO8
13	Explain the phenomenon of diffraction and how Fresnel gave a correct interpretation of it.	Understand	Learner to recall the principle of diffraction andunderstand how Fresnel interpreted it.	CO7, CO8
14	Diffraction phenomenon can be divided into two general classes. Explain and sketch the experimental arrangements.	Understand	Learner to recall the principle of diffraction andunderstand the different types with diagrams.	CO7, CO8
15	Give the theory of Fraunhofer diffraction due to a single slit and hence obtain the condition for maxima and minima.	Understand	Learner to recall the principle of Fraunhofer diffraction and understand its implication on single slit.	CO7, CO8
16	Give the expressions for intensities of various maximas in Fraunhofer diffraction due to single slit and explain the intensity distribution graph.	Understand	Learner to recall the principle of Fraunhofer diffraction and understand how the intensity graph is evolved.	CO7, CO8

17	Discuss the theory of Fraunhofer diffraction due to double slits and derive the conditions for principal maxima and minima.	Understand	Learner to recall the principle of Fraunhofer diffraction and understand its implication on double slit	CO7, CO8
18	Discuss the theory of Fraunhofer diffraction due to N slits and derive the conditions for principal maxima and minima.	Understand	Learner to recall the principle of Fraunhofer diffraction and understand its implication on N-slit	CO7, CO8
19	Compare the important phenomena of interference and diffraction exhibited by light. What is plane transmission grating? Discuss its construction	Understand	Learner to recall the principle of diffraction andinterference andunderstand the comparison of the phenomena and about the grating element.	CO7, CO8
20	Explain the theory of Fraunhofer diffraction due to diffraction grating? Discuss its construction.	Understand	Learner to recall the Fraunhoferdiffraction andunderstand its implication on diffraction grating.	CO7, CO8
21	How will diffraction pattern form when white light is used to study the Fraunhofer diffraction due to diffraction grating.	Understand	Learner to recall the Fraunhoferdiffraction and understand its implication on diffraction grating.	CO7, CO8
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.	Apply	Learner to recall the concept of Young’ s double slit experiment andapply the formula to the given data to find the fringe width in the obtained pattern	CO7, CO8
2	Two coherent sources of monochromatic light of wavelength 6000 A^oproduce 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	Apply	Learner to recall the principle of Young’ s double slit experiment and understand the working principle andapply the formula to the given data to find the distance between the two coherent sources	CO7, CO8
3	In a Newton’s rings experiment, the diameter of 15^{th} ring was found to be 0.59 cm and that of 5^{th} ring is 0.336 cm. If the radius of curvature of lens is 100 cm, find the wavelength of the light.	Apply	Learner to recall the concept of Newton’s rings experiment andapply the formula to the given data to find thedistance between the two coherent sources	CO7, CO8
4	Newton’s rings are observed in the reflected light of wavelength 5900A^o. The diameter of tenth dark ring is 0.5 cm. Find the radius of curvature of the lens used.	Apply	Learner to recall the principle and understand concept of Newton’s rings experiment and apply the formula to the given data to find the radius of curvature of the lens	CO7, CO8
5	Newton’s rings formed by sodium light between a flat glass plate and a convex lens are viewed normally. What will be	Apply	Learner to recall the principle and understand the concept of Newton’s rings experiment and	CO7, CO8

	the order of the dark ring which will have double the diameter of that of the 40^{th} dark ring.		apply the formula to the given data to find the order of the ring	
6	The diameter of 9^{th} dark ring in Newtons rings experiment is 0.29 cm. What is the diameter of 16^{th} dark ring when λ =6000 A^o	Apply	Learner to recall the principle and understand concept of Newton's rings experiment and apply the formula to the given data to find the diameter of the required ring	CO7, CO8
7	Find the highest order that can be seen with a grating having 15000 lines per inch. The wavelength of light used is 600 nm.	Apply	Learner to recall the principle and understand concept of diffraction at grating element and apply the formula to the given data to find the highest order of the diffraction for grating.	CO7, CO8
8	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?	Apply	Learner to recall the principle and understand concept of diffraction at grating element and apply the formula to the given data to find the visible order.	CO7, CO8
9	A grating has 6000 lines per cm. Find the angular separation between two wavelengths 500 nm and 510 nm in the 3^{rd} order.	Apply	Learner to recall the principle and understand concept of diffraction at grating element and apply the formula to the given data to find the angular separation between two given wavelengths.	CO7, CO8
10	A diffraction grating used at normal incidence gives a line (5500 A^o) in a certain order superposed on the violet line (4050 A^o) of the next higher order. If the angle of diffraction is 40^o. How many lines per cm are there in the grating?	Apply	Learner to recall the principle and understand concept of diffraction at grating element andapply the formula to the given data to find the power of the grating used.	CO7, CO8
MODULE-V				
LIGHT AND OPTICS				
Part – A (Short Answer Questions)				
1	When can we call a body in motion to execute a periodic motion? Define it.	Remember	....	CO9
2	When can we call a body executing periodic motion to be simple harmonic.	Remember	....	CO9
3	Define amplitude of a body executing simple harmonic motion.	Remember	....	CO9
4	Define time period of a body executing simple harmonic motion	Remember	....	CO9

5	Define phase of a body executing simple harmonic motion	Remember	....	CO9
6	Showthe expression for the velocity of a body executing simple harmonic motion.	Understand	Learner to recall the concept of simple harmonic motion and understand and write the velocity of a body executing simple harmonic motion.	CO9
7	Define frequency of a body executing simple harmonic motion.	Remember	....	CO9
8	Define the characteristics of simple harmonic motion	Remember	....	CO9
9	Distinguish between free and forced oscillation.	Understand	Learner to recall the concept of free and forced oscillations and understand the differences between them.	CO9
10	Explain the two forces which act on a damped harmonic oscillator.	Understand	Learner to recall the concept of damped oscillations and understand the two forces which act on a damped harmonic oscillator.	CO9
11	What is the definition of the term “wave motion”?	Remember	....	CO10
12	Summarize the characteristics of wave motion.	Understand	Learner to recall the concept of wave motion and understand its characteristics.	CO10
13	Compare the three different types of damped oscillations?	Understand	Learner to recall the concept of damped oscillations and understand the comparison of different types of damped motion.	CO9
14	What are the forces which act on a body executing forced vibrations?	Remember	....	CO9
15	Explain the phenomena involved in stationary wave.	Understand	Learner to recall the concept of stationary wave andunderstand the phenomena involved in it	CO10
16	Explain the phenomena involved in a progressive wave.	Understand	Learner to recall the concept of progressive wave andunderstand the phenomena involved in it	CO10
17	What are the laws of a stretched string?	Remember	....	CO10
18	What is a longitudinal wave? Write the wave equation of longitudinal wave.	Remember	....	CO10
19	What is a transverse wave? Write the wave equation of transverse wave.	Remember	....	CO10
20	Compare a longitudinal wave with a transverse wave.	Understand	Learner to recall the concept of types of waves andunderstand the comparison of longitudinal and transverse waves.	CO10

Part – B (LONG ANSWER QUESTIONS)				
1	Derive the equation of a motion of a Simple mechanical harmonic oscillator.	Understand	Learner to recall the concept of types of waves andunderstand the comparison of longitudinal and transverse waves.	CO9
2	Summarize the concept of simple harmonic motion and its characteristics.	Understand	Learner to recall the concept of simple harmonic motion and understand its characteristics	CO9
3	Explain the terms i) displacement ii) velocity iii) Acceleration of a simple harmonic oscillator along with their expressions	Understand	Learner to recall the concept of simple harmonic motion and understand its characteristics	CO9
4	Show an expression for the potential energy of a simple harmonic oscillator	Understand	Learner to recall the concept of simple harmonic motion and understand finding the expression for potential energy.	CO9
5	Find an expression for the kinetic energy of a simple harmonic oscillator	Understand	Learner to recall the concept of simple harmonic motion and understand finding theexpression for kinetic energy.	CO9
6	Summarize how the energy of body executing simple harmonic motion is proportional to the square of the frequency and square of the amplitude.	Understand	Learner to recall the concept of simple harmonic motion and understand summarizing how it is related to frequency and amplitude.	CO9
7	Show the differential equation of a damped harmonic oscillator and illustrate the conditions of different types of damping	Understand	Learner to recall the concept of damped oscillations and understand arriving at the differential equation and the types of damping.	CO9
8	Illustrate the motion of damped oscillator for the cases of light damping, heavy damping and critical damping with a neat sketch of the graph	Understand	Learner to recall the concept of damped oscillations and understand arriving at the differential equation and the types of damping.	CO9
9	Discuss the oscillations and amplitude variation with respect to forcing frequency in case of forced damped oscillator.	Understand	Learner to recall the concept of forced oscillations andunderstand how the oscillations and amplitude with effect to forcingfrequency	CO9
10	Explain the term “wave motion” with its characteristics and the properties that a wave needs in a medium for it to propogate.	Understand	Learner to recall the concept of forced oscillations andunderstand how the oscillations and amplitude with effect to forcing frequency	CO10
11	Find the equation of motion of a plane progressive wave and the differential form of wave motion	Understand	Learner to recall the concept of progressive wave andunderstand how to arrive at the equation of motion along with its differential form.	CO10

12	Discuss the various types of waves and the propagation mechanism of transverse and longitudinal waves	Understand	Learner to recall the concept of mechanism of propagation ofwave andunderstand discussing the mechanism invarious types of waves.	CO10
13	What is a transverse wave? Derive the wave equation of transverse wave.	Understand	Learner to recall the concept of transverse wave andunderstand how to arrive at the wave equation for it.	CO10
14	Develop an expression for the reflection and transmission amplitudes, when a transverse wave is travelling along X-Direction in a string.	Apply	Learner to recall the concept of transverse wave andunderstand the forces acting on it and apply the boundary conditions to arrive at expression for the reflection and transmission amplitudes	CO10
15	What is a longitudinal wave? Derive the wave equation of longitudinal wave.	Understand	Learner to recall the concept of transverse wave andunderstand how to arrive at the wave equation for it.	CO10
16	Relate the displacement and frequency of a particle executing simple harmonic motion	Understand	Learner to recall the concept of simple harmonic motion andunderstand how to arrive at their relation with one another.	CO9
17	Find the velocity of transverse wave propagation along a stretched string and obtain the frequencies of vibration for a string of length*l*	Understand	Learner to recall the concept of transverse wave andunderstand how to arrive at the velocity of wave and frequency of vibration for a string	CO10
18	Explain the terms: (i) Periodic motion (ii) Oscillatory motion (iii) Damped and undamped oscillations (iv) Forced oscillations	Understand	Learner to recall the concept of simple harmonic motion andunderstand its characteristics.	CO9
19	Compare how progressive waves are different from stationary waves.	Understand	Learner to recall the concept of progressive waves and stationary waves andunderstand how to compare them.	CO10
20	Explain: i) Longitudinal wave ii) Transverse wave and iii) progressive waves iv) Laws of vibrations of stretched strings	Understand	Learner to recall the concept of waves and vibrations in strings andunderstand its characteristics.	CO9
Part – C (Analytical Questions)				
1	A particle executes a S.H.M of period 10 seconds and amplitude of 1.5 meter. Calculate its maximum acceleration and velocity.	Apply	Learner to recall the principle and understand concept of Simple Harmonic motion and apply the formula to the given data to find the maximum acceleration and velocity.	CO9

2	A body executing S.H.M has its velocity 16cm/s when passing through its centre mean position. If it goes 1 cm either side of mean position, calculate its time period.	Apply	Learner to recall the principle and understand concept of Simple Harmonic motion and apply the formula to the given data to find the time period.	CO9
3	A body of mass 5 gm is subjected to an elastic force of 40 dyne/cm, and a frictional force of 5 dyne-sec/cm. If it is displaced through 2 cm and then released. Find whether the resulting motion is oscillatory or not? Also find the time period if it is oscillatory.	Apply	Learner to recall the principle and understand concept of forced oscillation andapply the formula to the given data to find the time period of the oscillations.	CO9
4	A 0.5 kg mass suspended from a linear spring of force constant 1000 N/m has a damping coefficient 0.05 Ns/m. An external force $F = F_0 \, Sin\,(pt)$ is applied, where F_0 = 25N and p is twice the natural frequency of the system, then calculate (i) Amplitude of resulting motion (ii) Phase shift of displacement with request to driving force.	Apply	Learner to recall principle and understand the concept of damped oscillation andapply the formula to the given data to find the amplitude and phase shift	CO9
5	Calculate the speed of transverse waves in a wire of 1 mm^2 cross section under the tension produced by 0.1 kg wt (specific gravity of material of wire = 9.81 gm/cm^3 and g = 9.81m/sec^2).	Apply	Learner to recall principle and understand the concept of transverse waves andapply the formula to the given data to find the speed of the waves.	CO10
6	A copper wire of radius 10^{-3} m has a wavelength of 1m. It is fixed at both ends and is subjected to a tension of 10^4 N. Calculate the fundamental frequency and the frequencies of the first two overtones. (Density of copper = 8.92 x 10^{-3} kg/m^3).	Apply	Learner to recall principle and understand the concept of harmonic waves andapply the formula to the given data to find the frequency of overtones.	CO9
7	A wire 50 cm long and of mass 6.5 x 10^{-1} kg is stretched so that it makes 80 vibrations per second. Find the stretched force in kg wt.	Apply	Learner to recall principle and understand the concept of harmonic waves andapply the formula to the given data to find the frequency of overtones.	CO9
8	A metal rod 150 cm long is fixed at the center When it vibrates longitudinally, the frequency is found to be 1200. Calculate the Young's modulus of the material of the rod. Its density is 8 g/cm^3.	Apply	Learner to recall principle and understand the concept of longitudinal waves andapply the formula to the given data to find the Young's modulus of the material.	CO9, CO10
9	A body executes S.H.M. such that its velocity at the mean position is 1m/s and acceleration at one of the extremities is 1.57 m/s^2. Calculate the time period of vibration.	Apply	Learner to recall principle and understand the concept of Simple Harmonic motion and apply the formula to the given data to find the time period of vibration.	CO9

10	The fundamental frequency of a sonometer wire increases by 5 Hz if its tension is increased by 21%. How will the frequency be affected if its length is increased by 10%?	Apply	Learner to recall principle and understand the concept of Harmonic waves andapply the formula to the given data to find the effect of increase in length of string on its frequency.	CO10, CO9

Prepared by:

Dr. B.M.Pratima, Associate Professor **HOD, ECE**