ARSD College, University of Delhi

Lesson Plan

Course Name : B.Sc. (Physical Science)Chemistry						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
IV	42224412	Waves and Optics	4	0	0	4
Teacher/Instructor(s)		Mrs Swati Jharwal				
Session		2022-23				

Course Objective:

- This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts.
- It explains basic ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves.
- The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

Course Learning Outcomes:

On successfully completing the requirements of this course, the students will have the skill and knowledge to:

- Understand Simple harmonic oscillation and superposition principle.
- Understand the importance of classical wave equation in transverse and longitudinal waves and solving a range of physical systems on its basis.
- Understand Concept of normal modes in transverse and longitudinal waves: their frequencies and configurations.
- Understand Interference as superposition of waves from coherent sources derived from same parent source. Demonstrate understanding of Interference experiments: Young's Double Slit, Fresnel's biprism, Llyod's Mirror, Newton's Rings.
- Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from apertures. Understand Fraunhoffer Diffraction from a slit.
- Concept of Polarization

Lesson Plan:

Unit	Learning Objective	Lecture	Topics to be covered

No.		No.	
1.	Superposition of Harmoni Oscilations and Wave Motion	1	Introduction to SHM
		2	Linearity and superposition principle
		3-4	Oscillations having equal frequencies
		5-6	Oscillations having different frequencies (Beats).
		7-8	Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods.
		9-10	Lissajous Figures (1:1 and 1:2) and their uses.
		11	Transverse waves on a string
		12	Travelling and standing waves on a string
		13-14	Normal Modes of a string
		15	Group velocity, Phase velocity.
		16	Plane waves. Spherical waves, Wave intensity
2.	Sound and wave Optics	17-18	Sound waves, production and properties.
		19-20	Intensity and loudness of sound. Decibels. Intensity levels
		21-22	musical notes. musical scale. Acoustics of buildings (General idea)
		23-24	Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.
3.	Interference	25-26	Division of amplitude and division of wave front. Young's Double Slit experiment.
		27	Lloyd's Mirror & Fresnel's Biprism
		28	Phase change on reflection: Stokes' treatment.
		29-30	Interference in Thin Films: parallel and wedge-shaped films.
		31-32	Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes)
		33-34	Newton's Rings: measurement of wavelength and refractive index
		35-38	Michelson's Interferometer: Construction and working. Idea of form of fringes. Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.
4.	Diffraction and Polarisation	39-40	Fraunhofer diffraction: Single slit.
		41-42	Fraunhofer diffraction: Double Slit
		43-44	Fraunhofer diffraction: Multiple slits & Diffraction grating
		45-46	Fresnel Diffraction: Half-period zones
		47	Zone plate
		48-49	Fresnel Diffraction pattern of a straight edge
		50-51	Fresnel Diffraction pattern at a slit
		52-53	Fresnel Diffraction pattern of a wire using half-period zone analysis
		54	Transverse nature of light waves
		55-57	Plane polarized light – production and analysis.
		58-60	

			Circular and elliptical polarization (General Idea).

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment		25
	• Quiz		
	• Class Test		
	• Attendance		
	• Assignment		
2.	End Semester Examination	3 hr	75

Details of the Course		
Unit	**Contents**	**Contact Hours**
1	**Superposition of Two Collinear Harmonic oscillations**: Simple harmonic motion (SHM). Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **Superposition of Two Perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. **Waves Motion-** General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity	16
2.	**Sound:** Sound waves, production and properties. Intensity and loudness of sound. Decibels. Intensity levels. musical notes. musical scale. Acoustics of buildings (General idea). **Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.	9
3.	**Interference:** Division of amplitude and division of wave front. Young's Double Slit experiment. Lloyd's Mirror & Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. **Michelson's Interferometer:** Construction and working. Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.	16
4.	**Diffraction:** Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **Polarization:** Transverse nature of light waves. Plane polarized light –	19

	production and analysis. Circular and elliptical polarization (General Idea).	
	Total	**60**

Suggested Books:

Sl. No.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Waves and Optics, S.P.Taneja, R.Chand and Pub., New Delhi	2017
2.	The Physics of Waves and Oscillations, N.K. Bajaj, Tata McGraw Hill.	1998
3.	Optics, 6th Edition, Ajoy Ghatak, McGraw-Hill Education, New Delhi	2017
4.	Fundamentals of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, R. Chand Publications.	2011
5	University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e,AddisonWesley.	1986

Mode of Evaluation:	Internal Assessment / End Semester Exam

Progress Report:

Unit No.	Learning Objective	Date	Topics to be covered
1.	Superposition of Harmoni Oscilations and Wave Motion		Introduction to SHM
			Linearity and superposition principle
			Oscillations having equal frequencies
			Oscillations having different frequencies (Beats).
			Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods.
			Lissajous Figures (1:1 and 1:2) and their uses.
			Transverse waves on a string
			Travelling and standing waves on a string
			Normal Modes of a string
			Group velocity, Phase velocity.
			Plane waves. Spherical waves, Wave intensity
2.	Sound and wave Optics		Sound waves, production and properties.
			Intensity and loudness of sound. Decibels. Intensity levels
			musical notes. musical scale. Acoustics of buildings (General idea)
			Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.
3.	Interference		Division of amplitude and division of wave front. Young's Double Slit experiment.
			Lloyd's Mirror & Fresnel's Biprism
			Phase change on reflection: Stokes' treatment.
			Interference in Thin Films: parallel and wedge-shaped films.
			Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes)
			Newton's Rings: measurement of wavelength and refractive index
			Michelson's Interferometer: Construction and working. Idea of form of fringes. Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.
4.	Diffraction and Polarisation		Fraunhofer diffraction: Single slit.
			Fraunhofer diffraction: Double Slit
			Fraunhofer diffraction: Multiple slits & Diffraction grating
			Fresnel Diffraction: Half-period zones
			Zone plate
			Fresnel Diffraction pattern of a straight edge
			Fresnel Diffraction pattern at a slit
			Fresnel Diffraction pattern of a wire using half-period zone analysis

			Transverse nature of light waves
			Plane polarized light – production and analysis.
			Circular and elliptical polarization (General Idea).