Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. III Semester

Paper-Major& Minor

WAVES AND OPTICS

Course Outcome

CO No.	Course Outcomes	Cognitive Level*
CO -I	Students will be able to understand the various aspects of harmonic oscillations and waves specially superposition of collinear and perpendicular harmonic oscillations	U, R, E
CO -II	Students will be able to explain various phenomena of daily life based on acoustic and optics	U, R, Ap, E
CO -III	Students will be able to understand interference and its Applications	R, U, Ap, An, E
CO -IV	Students will understand diffraction and be able to outline the use of optical instruments depending on diffraction. Will be able to apply Rayleigh's criterion to optical instruments	R, U, An, Ap, E, C
CO -V	Students will understand polarization, double refraction in anisotropic media and will be able to make use of optical instruments depending on polarization. Will be able to apply Huygen's principle to the phenomenon of polarization	U, An, Ap, E, R

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Practical	2	40	60	**100**
Total	**6**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Waves** **1.1 Superposition of Two Collinear Harmonic Oscillations:** Linearity and Superposition Principle- (i) Oscillations having equal frequencies and (ii) Oscillations having different frequencies (Beats). **1.2 Superposition of Two Perpendicular Harmonic Oscillations:** Graphical and Analytical Methods; Lissajous Figures (1:1 and 1:2 frequency ratio) and their uses. **1.3 Wave Motion :** Transverse wave in Stretched string ; Travelling and standing waves; Normal modes of string; Phase velocity; Group velocity ; Plane and Spherical waves; wave intensity. **Keywords/Tags:** Harmonic Oscillation, Superposition Principle, Wave Motion.	12
II	**Sound and Light Waves** **2.1 Sound:** Simple harmonic motion; Forced vibrations and resonance; Fourier Theorem; Application to saw tooth wave and square wave; Intensity and loudness of sound; Decibels, Intensity levels; Musical notes; Musical scale. 2.2 **Acoustics of buildings:** reverberation and time of reverberation; Absorption coefficient; Sabine's formula; Measurement of reverberation time; Acoustic aspects of halls and auditoria 2.3 **Wave optics:** Electromagnetic nature of light; Wave front; Huygens Principle. 2.4 Electro-optic, Magneto-optic and acousto-optic effects (elementary idea) **Keywords/Tags**: Sound, Musical notes, Acoustics of buildings, Wave optics	
III	**Interference of light** 3.1 Interference: Conditions necessary for interference, Interference by	12

	Division of amplitude and division of wavefront; Young's Double Slit experiment; Lloyd's Mirror and Fresnel's Biprism. 3.2 Interference in Thin Films: Stokes' Law; Interference in parallel and wedge-shaped films; Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes); Applications of thin films interference: Antireflection coating; Dielectric Mirrors; Interference filter. 3.3 Newton's Ring: Measurement of wavelength and refractive index. 3.4 Michelson's Interferometer: (1) formation of fringes, (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, (5) Visibility of fringes. **Keywords/Tags:** Interference, Thin films interference, Michelson's Interferometer.	
IV	**Diffraction** 4.1 Introduction; Distinction between interference and diffraction; Types of diffraction; Distinction between Fresnel and Fraunhofer diffraction. 4.2 Fresnel's diffraction: Fresnel's Assumptions; Huygens Fresnel's Theory; Half period zone; Construction and theory of Zone plate; Diffraction at straight edge; Diffraction at a circular aperture. 4.3 Fraunhofer diffraction: Diffraction due to single, double and N slits; Plane diffraction grating. 4.4 Resolving and dispersive power: Rayleigh's criterion; Limit of resolution of the eye; Resolving power of Grating and Telescope; Expression for dispersive power of prism. **Keywords/Tags:** Diffraction, Zone plate, Plane diffraction grating, Resolving power.	**12**
V	**Polarisation** 5.1 Introduction: Polarized light and its representation; Difference in Polarized and unpolarized light; Types of Polarisation; Application of polarization: Sunglasses; Three- dimensional movies; Photography. 5.2 Production of polarized light: Production of polarized light by	

	reflection, refraction, double refraction, scattering and selective absorption; Brewster's Law; Polaroid sheets; Polarizer and analyzer; Malus law. 5.3 Anisotropic Crystals: Doubly refracting crystals (Uniaxial); Extra-ordinary rays and Ordinary rays; Polarization by double refraction and Huygens theory; Nicol prism; Retardation plates: Quarter-wave plate and Half-wave plate. 5.4 Optical Activity: Optical rotation; Specific rotation; Half shade & Biquartz polarimeter. **Keywords/Tags:** Polarized light, Anisotropic Crystals, Optical Activity.	

References

Test/Reference Books:

1. **Fundamentals of Optics**, F.A. Jenkins and H.E. White,1996 ,McGraw Hill.
2. **The Physics of Waves and Oscillations,** N. K. Bajaj, 1998, McGraw Hill.
3. **Principles of Optics,** B. K. Mathur , 1995,Gopal Printing
4. **University Physics,** F.W. Sears, M.W.Zemansky and H.D.Young1986, Addison Wesley
5. **Optics,** A.K.Ghatak ,McGraw Hill
6. **Principles of Optics,** Max Born and Wolf ,Pregmon Press
7. **Optics and Atomic Physics,** D.P.Khandelwal Himalaya Publication
8. **Optics,** Brijlal and Subramaniyam , S.Chand Publications
9. **Physics for Degree Students,** C. L. Arora and P.S. Hemne, S.Chand Publications.
10. **The Physics of Vibrations and Waves,** H. J Pain, 2013 John Wiley and Sons,
11. **Fundamental of Optics,** A Kumar., H. R Gulati. and D. R Khanna., S. Chand Publications

Web Links:

1. https://youtu.be/olTD-mpsU4E Waves and Oscillations by Prof. M S Santhanam, Department of Physics, IISER Pune.

2. https://youtu.be/SUVXHfUVSY Video Demonstrations in Laser and Optics by Professor Shaoul Ezekiel, MIT.

List of Experiments

1) To determine the dispersive power of the material of prism using spectrometer.
2) To plot the i-δ curve for a given prism using spectrometer and then determines the refractive index of the material of the prism.
3) To determine the wavelength of main spectral lines of mercury light with the help of plane transmission grating.
4) To determine the wavelength of monochromatic light source with the help of Newton's ring method.
5) To determine the radius of curvature of a Plano-convex lens with the help of Newton's ring method.
6) To determine the wavelength of monochromatic light source using Fabry Perot Etalon.
7) To determine the dispersive power of plane transmission grating.
8) To determine the resolving power of grating.
9) To determine the diameter / thickness of a thin wire by diffraction method
10) Study of diffraction at Straight edge.
11) To determine the resolving power of telescope.
12) To determine the polarising angle of the prism and to determine the refractive index of the material of prism using Brewster's law.
13) To determine wavelength of sodium light using Fresnel Biprism.
14) To determine the specific rotation of a given sugar solution by bi-quartz polarimeter.
15) To determine the refractive indices of O-ray and E-ray for calcite prism using spectrometer.
16) To determine the refractive indices of O-ray and E-ray for quartz prism using spectrometer.
17) Study of Laser holography and Interferometry. (SPONSARED BY DBT STAR)
18) Study of Malus Law. (SPONSARED BY DBT STAR)
19) To study Lissajous Figures with the help of CRO
20) Verification of Faraday's law. (SPONSARED BY DBT STAR)

B.Sc. III SEM

WAVES AND OPTICS

ELECTIVE

Course Outcome

CO No.	Course Outcomes	Cognitive Level*
CO-I	Students will be able to understand the various aspects of harmonic oscillations and waves specially superposition of collinear and perpendicular harmonic Oscillations	U, R, E
CO-II	Students will be able to explain various phenomena of daily life based on acoustic and optics	U, R, Ap, E
CO-III	Students will be able to understand interference and its Applications	R, U, Ap, An, E
CO -IV	diffraction. Will be able to apply Rayleigh's criterion to optical instruments	U,R, An, C
CO -V	Students will understand polarization, double refraction in anisotropic media and will be able to make use of optical instruments depending on polarization. Will be able to apply Huygen's principle to the phenomenon of polarization	U, An, Ap, E, R

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	40	60	**100**
Practical	1	40	60	**100**
Total	**4**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 3.5 Hrs. per week

Total No. of Lectures: 45 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Waves** **1.1 Superposition of Two Collinear Harmonic Oscillations:** Linearity and Superposition Principle- (i) Oscillations having equal frequencies and (ii) Oscillations having different frequencies (Beats). **1.2 Superposition of Two Perpendicular Harmonic Oscillations:** Graphical and Analytical Methods; Lissajous Figures (1:1 and 1:2 frequency ratio) and their uses. **1.3 Wave Motion :** Transverse wave in Stretched string ; Travelling and standing waves; Normal modes of string; Phase velocity; Group velocity ; Plane and Spherical waves; wave intensity. **Keywords/Tags:** Harmonic Oscillation, Superposition Principle, Wave	12

	Motion.	
II	**Sound and Light Waves** **2.1 Sound:** Simple harmonic motion; Forced vibrations and resonance; Fourier Theorem; Application to saw tooth wave and square wave; Intensity and loudness of sound; Decibels, Intensity levels; Musical notes; Musical scale. 2.2 **Acoustics of buildings:** reverberation and time of reverberation; Absorption coefficient; Sabine's formula; Measurement of reverberation time; Acoustic aspects of halls and auditoria 2.3 **Wave optics:** Electromagnetic nature of light; Wave front; Huygens Principle. 2.4 Electro-optic, Magneto-optic and acousto-optic effects (elementary idea) **Keywords/Tags**: Sound, Musical notes, Acoustics of buildings, Wave optics	**12**
III	1.1 Interference: Conditions necessary for interference, Interference by Division of amplitude and division of wavefront; Young's Double Slit experiment; Lloyd's Mirror and Fresnel's Biprism. 1.2 Interference in Thin Films: Stokes' Law; Interference in parallel and wedge-shaped films; Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes); Applications of thin films interference: Antireflection coating; Dielectric Mirrors; Interference filter. 1.3 Newton's Ring: Measurement of wavelength and refractive index. 1.4 Michelson's Interferometer: (1) formation of fringes, (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, (5) Visibility of fringes. **Keywords/Tags:** Interference, Thin films interference, Michelson's Interferometer.	**12**
IV	**Diffraction and Polarisation** 5.5 **Diffraction**: Distinction between interference and diffraction;	**12**

	Types of diffraction; Distinction between Fresnel and Fraunhofer diffraction. 5.6 Fresnel's diffraction: Fresnel's Assumptions; Huygens Fresnel's Theory; Half period zone. 5.7 Fraunhofer diffraction: Diffraction due to single, N slits; Plane diffraction grating. 5.8 **Polarisation**: Polarized light and its representation; Difference in Polarized and unpolarized light; Types of Polarisation; Application of polarization: Sunglasses; Three- dimensional movies; Photography. 5.9 Production of polarized light: Production of polarized light by reflection, refraction, double refraction, scattering and selective absorption; Brewster's Law; Polaroid sheets; Polarizer and analyzer; Malus law. **Keywords/Tags:** Diffraction, Zone plate, Plane diffraction grating Polarized light.	

References

Test/Reference Books:

1. **Fundamentals of Optics**, F.A. Jenkins and H.E. White,1996 ,McGraw Hill.
2. **The Physics of Waves and Oscillations,** N. K. Bajaj, 1998, McGraw Hill.
3. **Principles of Optics,** B. K. Mathur , 1995,Gopal Printing
4. **University Physics,** F.W. Sears, M.W.Zemansky and H.D.Young1986, Addison Wesley
5. **Optics,** A.K.Ghatak ,McGraw Hill
6. **Principles of Optics,** Max Born and Wolf ,Pregmon Press
7. **Optics and Atomic Physics,** D.P.Khandelwal Himalaya Publication
8. **Optics,** Brijlal and Subramaniyam , S.Chand Publications
9. **Physics for Degree Students,** C. L. Arora and P.S. Hemne, S.Chand Publications.
10. **The Physics of Vibrations and Waves,** H. J Pain, 2013 John Wiley and Sons,
11. **Fundamental of Optics,** A Kumar., H. R Gulati. and D. R Khanna., S. Chand Publications

Web Links:

1. https://youtu.be/olTD-mpsU4E Waves and Oscillations by Prof. M S Santhanam, Department of Physics, IISER Pune.

2. https://youtu.be/SUVXHfUVSY Video Demonstrations in Laser and Optics by Professor Shaoul Ezekiel, MIT.

List of Experiments

1. To determine the dispersive power of the material of prism using spectrometer.

2. To plot the i-δ curve for a given prism using spectrometer and then determines the refractive index of the material of the prism.

3. To determine the wavelength of main spectral lines of mercury light with the help of plane transmission grating.

4. To determine the wavelength of monochromatic light source with the help of Newton's ring method.

5. To determine the radius of curvature of a Plano-convex lens with the help of Newton's ring method.

6. To determine the wavelength of monochromatic light source using Fabry Perot Etalon.

7. To determine the dispersive power of plane transmission grating.

8. To determine the resolving power of grating.
9. To determine the diameter / thickness of a thin wire by diffraction method
10. Study of diffraction at Straight edge.
11. To determine the resolving power of telescope.
12. To determine the polarising angle of the prism and to determine the refractive index of the material of prism using Brewster's law.
13. To determine wavelength of sodium light using Fresnel Biprism.
14. To determine the specific rotation of a given sugar solution by bi-quartz polarimeter.
15. To determine the refractive indices of O-ray and E-ray for calcite prism using spectrometer.
16. To determine the refractive indices of O-ray and E-ray for quartz prism using spectrometer.
17. Study of Laser holography and Interferometry. (SPONSARED BY DBT STAR)
18. Study of Malus Law. (SPONSARED BY DBT STAR)
19. To study Lissajous Figures with the help of CRO
20. Verification of Faraday's law. (SPONSARED BY DBT STAR)

Other experiments of the same difficulty level may be added.
Student needs to perform at least 06 experiments.

Learning Resources

Suggested Readings:

1. Prakash I. & Ramakrishna, **—A Text Book of Practical Physics‖**, Kitab Mahal, 2011,11/e.
2. Squires G. L., **"Practical Physics‖**, Cambridge University Press, 2015, 4/e.
3. Flint B. L. and Worsnop H. T., **—Advanced Practical Physics for students‖**, Asia Publishing House, 197.
4. Chattopadhyay D. & Rakshit P. C., **—An Advanced Course in Practical Physics‖**, New Central Book Agency.
5. Chattopadhyay D., Rakshit P.C. and Saha B., **—An Advanced Course in Practical Physics‖**, New Central Book Agency P. Ltd.
6. Singh S.P., —Advanced Practical Physics‖, Pragati Prakashan.
7. Tayal D. C., **—University Practical Physics‖**, Himalaya Publishing House
8. Kumar P. R. Sasi, **— Practical Physics‖**, PHI Publication
9. Srivastava Anchal, Shukla R. K., **—Practical Physics‖**, New Age International Publishers.
10. Agarwal D. C., **—Experimental electronics‖**, Technical Publishing House.
11. Srivastava J. P., **—Elements of Solid state Physics‖**, PHI Publication.
12. Instruction Manual for doing experiments in Physics by R.Shrinivasan and K.R. Pariolkar

web links

1. https:/www.vlab.co.in/broad-area-physical-sciences , Virtual Labs (Physical Sciences),Ministry of Education
2. https://storaye.yoouleapis.com/uniguecourses/online. html, SWAYAM Online Courses