UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN PHYSICS

SYLLABUS WITH EFFECT FROM 2023-2024

237C4A

COURSE	**FOURTH SEMESTER – CORE COURSE-IV**
COURSETITLE	**OPTICS AND SPECTROSCOPY**
CREDITS	**5**
COURSE OBJECTIVES	To provide an in-depth understanding of the basics of various phenomena in geometrical and wave optics; To explain the behaviour of light in different mediums; To understand the differences in the important phenomena namely interference, diffraction and Polarization and apply the knowledge in day to day life; To understand the design of optical systems and methods to minims aberrations; To solve problems in optics by selecting the appropriate equations and performing numerical or analytical calculations.

UNITS	COURSE DETAILS
UNIT-I	**LENS AND PRISMS:** Fermat's Principle Of Least Time – Postulates of Geometrical Optics – Thick and Thin Lenses – Focal Length, Critical Thickness, Power and Cardinal Points of a Thick Lens – Narrow Angled Prisms. **Lens:** Lens Makers Formula (No Derivation) – Aberrations: Spherical Aberration,Chromatic Aberrations, Coma, and Astigmatism– Curvature of the Field – Distortion – Chromatic Aberrations Methods. **Prism:** Dispersion, Deviation, Aberrations - Applications Rainbows and Halos, Constant Deviation Spectroscope. **Eyepieces:**Advantage of an Eyepiece over a Simple Lens – Huygen'sand Ramsden's Eyepieces, Construction and Working –Merits and Demerits of the Eyepiece. **Resolving power:** Rayleigh's Criterion for Resolution – Limit of Resolution for the Eye – Resolving Power of, (I) Prism (Ii) Grating (Iii) Telescope
UNIT-II	**INTERFERENCE:** Division of Wave Front, Fresnel's Biprism – Fringes with White Light – Division of Amplitude: Interference in Thin Films due to, (i) Reflected Light, (ii) Transmitted Light – Colours of Thin Films Applications – Air Wedge – Newton's Rings. **Interferometers :** Michelson's Interferometer – Applications, (i) Determination of the Wavelength of a Monochromatic Source of Light, (ii) Determination of the Wavelength and Separation D1 And D2Lines of Sodium Light, (iii) Determination of a Thickness of a Mica Sheet.
UNIT-III	**DIFFRACTION:** Fresnel's assumptions – zone plate – action of zone plate for an incident spherical wave front – differences between a zone plate and a convex lens –Fresnel type of diffraction – diffraction pattern due to a straight edge – positions of maximum and minimum intensities – diffraction due to a narrow slit – Fraunhofer type of diffraction – Fraunhofer diffraction at a single slit – plane diffraction grating– experiment to determine

	wavelengths – width of principal maxima.
UNIT-IV	**POLARISATION:** Optical Activity – Optically Active Crystals –Polarizer and Analyser– Double Refraction – Optic Axis, Principal Plane – Huygens's Explanation of Double Refraction in Uniaxial Crystals – Polaroids and Applications – Circularlyand Elliptically Polarized Light –Quarter Wave Plate – Half Wave Plate – Production and Detection of Circularly and Elliptically Polarized Lights – Fresnel's Explanation – Specific Rotation – Laurent Half Shade Polarimeter – Experiment to Determine Specific Rotatory Power.
UNIT-V	**SPECTROSCOPY:** Infra-Red Spectroscopy Near Infra-Red and Far Infra-Red – Properties – Origin of IR spectra – IR Spectrophotometer – Applications Interpretation of IR Spectra – CH, CO, CN Bending and Stretching Vibrational Modes Only – Scattering of Light – Raman Effect –Classical Theory –Quantum Theory –Mutual Exclusion Principle – Raman Spectrometer-Characteristics of Raman Lines –Applications – Ultraviolet and Visible Spectroscopy –Properties – Spectrophotometer.
TEXT BOOKS	1. Subramaniam. N&Brijlal, 2014,Optics, 25thedition,S.Chand&Co. 2. S.L.Gupta,V.Kumar& R.C.Sharma,1997,Elements of Spectroscopy, 13th Edition, Pragati Prakashan, Meerut. 3. G.Aruldhass,2000,Molecular Structure and Spectroscopy,IIedition.PHIPvt Ltd, New Delhi. 4. P.R.Sasikumar, 2012, Photonics, PHIPvt Ltd, New Delhi. 5. K.Rajagopal, 2008, Engineering Physics, PHIPvt Ltd, New Delhi. 6. V.Rajendran, 2012, Engineering Physics, Tata McGraw Hill.
REFERENCE BOOKS	1. Agarwal B.S, 2011,Optics, KedernathRamnath Publishers, Meerut. 2. Sathyaprakash, 1990,Optics,VII edition, RatanPrakashanMandhir, New Delhi. 3. C.N.Banewell, 2006, Introduction to Molecular Spectroscopy,IVedition,TMH Publishing Co,New Delhi. 4. AjoyGhatak, 2009,Optics, 4thedition, PHIPvt Ltd, New Delhi. 5. Singh &Agarwal,2002,Optics and Atomic Physics, 9thedition, PragatiPrakashan Meerut. 6. D.Halliday,R.Resnick and J. Walker, 2001, Fundamentals of Physics,6th edition, Willey, New York. 7. JenkinsA.Francis& White, 2011, Fundamentals of Optics, 4th edition, McGraw Hill Inc., NewDelhi.

WEBLINKS	1. https://science.nasa.gov/ems/ 2. https://www.youtube.com/watch?v=tL3rNc1G0qQ&list=RDCMUCz wo7UlGkb-8Pr6svxWo-LA&start_radio=1&t=2472 3. https://science.nasa.gov/ems/ 4. https://www.youtube.com/watch?v=tL3rNc1G0qQ&list=RDCMUCz wo7UlGkb-8Pr6svxWo-LA&start_radio=1&t=2472 5. https://imagine.gsfc.nasa.gov/educators/gammaraybursts/imagine/ind ex.html 6. http://www.thephysicsmill.com/2014/03/23/sky-blue-lord-rayleigh-sir-raman-scattering/ 7. http://www.thephysicsmill.com/2014/03/23/sky-blue-lord-rayleigh-sir-raman-scattering/

COURSE OUTCOMES:

At the end of the course,the student will be able to:

COURSE OUTCOMES	**CO1**	Outline basic knowledge of methods of rectifying different defects in lenses, articulate technological applications of eyepieces
	CO2	Discuss the principle of superposition of wave, use these ideas to understand the wave nature of light through working of interferometer
	CO3	Extend the knowledge about nature of light through diffraction techniques; apply mathematical principles to analyse the optical instruments
	CO4	Interpret basic formulation of polarization and gain knowledge about polarimeter, appraise its usage in industries
	CO5	Relate the principles of optics to various fields of IR, Raman and UV spectroscopy and understand their instrumentation and application in industries

MAPPING WITH PROGRAM OUT COMES:

Map course outcomes**(CO)**for each course with program outcomes**(PO)** in the3- point scale of STRONG(**S**), MEDIUM(**M**) and LOW(**L**).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	M	M	M	S	S	M	M
CO2	M	S	M	S	M	S	M	M	S	S
CO3	S	M	S	S	S	M	S	S	M	M
CO4	S	M	S	M	M	S	M	M	S	M
CO5	S	M	S	M	S	S	M	S	S	S

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