CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

B.Sc. PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**FUNDAMENTALS OF OPTICS**				
Type of Course	**Minor (SET III: SEMICONDUCTOR PHYSICS)**				
Semester	**II**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basics of Physics and Chemistry (Plus Two Level)				
Course Summary	This syllabus explores how light behaves, from reflection and bending to creating specific light sources and transmitting them through thin cables.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze the principles of reflection and refraction, applying them to explain image formation by mirrors and lenses.	An	C	Instructor-created exams / Quiz/ Practical Assignment

CO2	Describe the phenomenon of wave interference and diffraction, and solve problems using concepts like the double-slit experiment.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Explain the concept of polarization and its applications, including the use of polarizers and analyzers.	U	C	Instructor-created exams / Quiz/ Practical Assignment
CO4	Describe the operating principles of lasers, including stimulated emission and population inversion, and identify different laser types.	U	C	Instructor-created exams / Home Assignments
CO5	Explain the concept of total internal reflection and apply it to understand light propagation through optical fibers.	Ap	F	Seminar Presentation / Group Tutorial Work
CO6	Able to explain the advantages and applications of optical fibers in communication and sensing.	U	C	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Reflection and Refraction**		**10**	**15**
	1	Reflection at plane Mirrors, Reflection at spherical mirror: Basic terms, paraxial rays and paraxial approximation, sign convention, spherical mirror equation, Focal point and focal length	3	
	2	Spherical mirror equation applied to concave mirror, Conjugate points, extended object, lateral magnification, convex mirror and plane mirror	3	
	3	Refraction at spherical surfaces, Gaussian relation	2	

	4	Lens equation, Lens maker's equation.	2	
	Section 3.3, 3.4, 3.12, 4.8 - 4.10 of chapter 3 and chapter 4 of Book 1			
II	**Wave optics**		**19**	**25**
	5	Interference, Young double slit experiment	2	
	6	Coherence and conditions for interference	1	
	7	Interference in thin parallel films	2	
	8	Interference in wedge shaped film, Angle of wedge and thickness of spacer, Colour of thin films	2	
	9	Newton's rings: determination of wavelength of light	2	
	10	Diffraction: Difference between diffraction and interference, Fresnel and Fraunhoffer type diffraction	1	
	11	Fraunhoffer diffraction at a single slit, double slit (Calculus method is excluded), Plane diffraction grating.	3	
	12	Polarization: Types of polarization, Brewster's law, Production of plane polarized light	2	
	13	Polarizer and analyser, Malu's law, Double refraction	2	
	14	Optical activity and specific rotation	2	
	Section 14.4 – 14.7,15.2, 15.5, 15.6 (upto 15.6.7), 17.6 - 17.7, 18.1, 18.2, 18.4, 18.7, 20.1, 20.2, 20.5, 20.6, 20.8 - 20.11, 20.27 - 20.29, Book 1			
III	**Lasers**		**8**	**15**
	15	Lasers, Thermal equilibrium, Absorption of a Photon, Spontaneous emission, Stimulated emission, Population inversion	2	

	16	Components of Laser and lasing action	3	
	17	Ruby laser, Nd-YAG laser, Helium Neon laser, Carbon dioxide laser, semiconductor laser.	3	
	Sections 22.1, 22.3, 22.4, 22.7, 22.8, 22.9, 22.14, 22.15, Book 1			
IV	**Fiber Optics**		**8**	**15**
	18	Introduction, Optical fiber, Total internal reflection	2	
	19	Propagation of light through optical fiber	1	
	20	Critical angle, Acceptance angle, Numerical Aperture, Modes of propagation	2	
	21	Classification of optical fibers, Losses in optical fiber, Applications	2	
	22	Fiber optic communication systems, fiber optic sensors.	1	
	Sections 24.1 - 24.6, 24.8, 24.10, 24.11, 24.15, 24.20 - 24.21, 24.23 (24.23.1-24.23.2), Book 1			
V	**PRACTICALS**		**30**	
	Conduct any 6 experiments from the given list and 1 additional experiment, decided by the teacher-in-charge, related to the content of the course. The 7th experiment may also be selected from the given list. Other experiments listed here may be used as demonstrations of the concepts taught in the course. Necessary theory of experiments can be given as Assignment/ Seminar.			
	1	**Determine the refractive index of (a) given liquid and (b)the material of a lens, by forming a liquid lens.** ● Through this experiment the students are expected to get the concepts of image formation, combination of lenses and radius of curvature of the surface of lens.		

		• Determine the radius of curvature of the lens by Boy's method and hence calculate the refractive indices.		
	2	**Determine the focal length of the combination of two lenses separated by a distance.** • Determine the focal lengths, f1 and f2 of the two lenses using an illuminated cross-slit screen holder, nodal slide(for placing the lenses) and plane mirror arrangement. • Place the two lenses separated by a distance d, determine the focal length, F of the combination and verify the relation • $\frac{1}{F} = \frac{1}{f1} + \frac{1}{f2} - \frac{d}{f1f2}$. • The combination of the lenses in the eyepiece of the spectrometer/ travelling microscope may be used for the study. • https://www.youtube.com/watch?v=IOlEEtyNPBg • https://www.youtube.com/watch?v=tNo4Ipk74SU		
	3	**Determination of the dispersive power of a solid prism using a spectrometer.** • Find the angle of the prism and the angle of minimum deviation for prominent lines of the mercury spectrum using a spectrometer. • Calculate the refractive indices corresponding to the colors and find the dispersive power of the material of the prism for two pairs of wavelengths.		
	4	**Refractive indices of quartz prism using spectrometer.** • Determine the refractive indices of quartz for the ordinary and extraordinary rays of a sodium vapour lamp by arranging the quartz prism at minimum deviation position in the spectrometer. • Verify the polarizations of the ordinary and extraordinary rays using a polaroid.		

	5	**Determination of wavelengths of mercury spectrum using diffraction grating and spectrometer.** ● Arrange the grating at normal incidence. ● Standardize the grating using the green line of mercury and then find the wavelengths of other prominent lines of the spectrum.		
	6	**Newton's rings-determination of the wavelength of sodium light** ● Form of Newton's rings in the air-film in between a plano-convex lens and a glass plate using sodium-source. ● Determine the radius of curvature by Boy's method and determine the wavelength of the source. ● Optional: In experiment 5 and 6, record a short video of the interference pattern, calibrate the video using scale marked on the glass plate, analyse the video using Tracker tool. From the intensity profile get the locations of the dark rings and calculate the wavelength of the source/thickness of the sample https://physlets.org/tracker/. https://www.youtube.com/watch?v=UCCPkJpUQEw		
	7	**Air wedge-determination of the radius of a thin wire/human hair/thin foil.** ● Form interference fringes using sodium-source, in the air-film in between wedge formed by placing the given sample between the glass plates. ● Measure the positions of the successive dark bands using a travelling microscope and determine the angle of the wedge and thickness of the sample given.		
	8	**Single slit diffraction using laser - Determination of slit width.** ● The laser light diffracted from the narrow slit is allowed to fall on a screen and record the maxima or minima points in a paper.		

		• From the width of the central maxima or the position of minimum intensity points, calculate the slit width. • Verify the slit width using a traveling microscope. • Wavelength of laser can be found using diffraction grating of known N.		
	9	**Study the specific rotation of the sugar solution using a polarimeter.** • Determine the specific rotation corresponding to different concentrations of the sugar dissolved in water. • Draw a graph between rotation and concentrations and verify the linear relationship.		
	10	**Verification of Malus's law using polarizer, analyzer and photo detector** • Unpolarized light is allowed to pass through a polarizer and is observed through an analyzer. • Vary the angle between the axes of polarizer and analyzer and measure the intensity of the light (current output of the photodetector). • Plot $\theta - I$ and $cos^2\theta - I$ graphs and verify the Malus's law. • A flat computer monitor (or LCD TV screen) in plain white color can be used as the source of linear polarized light. • The ambient light sensor of the smartphone and the orientation sensor of the smartphone can be used to measure the illuminance and the angles respectively. • A small piece of polarizer (a square of about 1 cm side) from an old calculator's display was placed over the ambient light sensor as analyser. • https://arxiv.org/pdf/1607.02659		
	11	**Spectrometer-Determination of the Cauchy's constants of the given prism** • Find the angle of the prism, the minimum deviation angles of the prominent lines of the mercury spectrum and hence calculate the refractive indices for the colors. • Determine A and B from the $\mu - \frac{1}{\lambda^2}$ graph.		

	12	**Viscosity of a liquid - Falling Ball Viscometer** ● Drop a polished steel ball into a glass tube of a somewhat larger diameter containing the liquid. ● Record the time required for the ball to fall at constant velocity through a specified distance between reference marks. ● Use the Stoke's law for the sphere falling in a fluid under effect of gravity, to estimate the viscosity of the liquid.		
	13	**Surface tension of liquid - Capillary rise method** ● Clamp a clean capillary tube by dipping its lower end into the liquid in the beaker. ● Measure the rise of water in the tube using a traveling microscope. ● Also measure the radius of the capillary tube using the traveling microscope and estimate the surface tension of the liquid. ● Density of the liquid can be determined using Hare's apparatus of can be given		
	14	**Viscosity of a liquid - Poiseuille's Method** ● Fill the liquid in a vertically fixed burette with its lower end attached to a capillary tube, placed in horizontal position using a rubber tube. ● Note the time taken to reach each 10cc of water and the height of the corresponding marking. ● Also measure the radius of the capillary tube using the traveling microscope and estimate the viscosity of the liquid.		
	15	**Static torsion Rigidity modulus** ● Using Searle's static torsion apparatus, determine the rigidity modulus of the material of the rod.		

Books and References:

1) A Textbook of Optics by N. Subramanyam, Brij Lal, M N Avadhanulu, 25TH Edition (Book 1)
2) Optics by Ajoy Ghatak, Tata McGrow-Hill (Book 2)

3) Optics by Eugene Hecht, Addison-Wesley (Book 3)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	3	2	2	1	2	0	3	1	1	0	2	1	0
CO 2	3	2	2	1	2	1	3	3	2	1	2	1	0
CO 3	3	2	3	2	2	1	3	2	2	1	2	1	0
CO 4	3	2	2	1	2	0	3	2	2	1	2	1	0
CO 5	2	3	2	1	2	1	3	2	2	1	3	1	0
CO 6	2	3	2	1	2	2	3	2	2	1	3	1	0

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/ Practical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	