Government PG College, Ambala Cantt

Course File (Session 2023-24)

Name of Professor: Dr. Harneet Kaur

Class: BSc-II/4th Semester/ SECTION: NM, CS

Subject code and Name:PH-402, Paper VIII: Wave and Optics II

SYLLABUS

Maximum Marks: 40 **Internal: 10**

Time: 3 hours

Note: The syllabus is divided into 4 units. 9 questions will be set. Question no 1 will be compulsory, it contains 6 parts (form all the four units) and answer should be brief but not in yes / no. Four more questions are to be attempted, selecting one question from each unit. Questions 2-9 may contain two or more parts. All questions carry equal marks. 20% numerical problems are to be set. Use of scientific (non-programmable) calculator is allowed

Unit-1 Polarization

Polarization and Double refraction, Polarisation by reflection, Polarisation by scattering, Malus Law, Phenomenon of double refraction, Huygen's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Optical activity, Fresnel's theory of rotation, Specific rotation, Polarimeters (half shade and Biquartz).

Unit-2 Fourier analysis

Fourier series, Fourier coefficients, odd functions, even functions, Fourier theorem, analysis of complex waves and its application for the solution of triangular and rectangular waves , half and full wave rectifier outputs.

Unit 3 Fourier transforms

Fourier transforms and its properties, Application of Fourier transform to following functions:

1. f(x)= e- x2/2 and f(x)=1 <|X|<a; |x| 0 >|X |>a

Geometrical Optics I Matrix methods in paraxial optics, effects of translation and refraction, derivation of thin lens and thick lens formulae, unit plane, nodal planes, system of thin lenses.

Unit 4 Geometrical Optics II

Chromatic, spherical, coma, astigmatism and distortion and aberrations and their remedies. **Fiber Optics** Optical fiber, Critical angle of propagation, Mode of Propagation, Acceptance angle, Fractional refractive index change, Numerical aperture, Types of optics fiber, Normalized frequency, Pulse dispersion, Attenuation, Applications, Fiber optic Communication, Advantages.

References

1 Born M and Wolf E, Principles of Optics, Pergaman Press

2 Jenkins and white, Fundamentals of Optics, McGraw Hill Book Co Ltd, New Delhi

3 Moller K D, Optics, University Science Books, Mill ally California

4 Tolansky, An Introduction to Interferometery, John Wiley & Sons, New Delhi

5 Shurcliff, Polarized Light Production and Use, Harward University Press, Cambridge, M A (USA)

6 Arora C L, Refresher Course in Physics Vol II, S Chand and Co, New Delhi.

COURSE OBJECTIVES

The course objectives outlined are as follows:

- **Understanding Polarization and Double Refraction**: Develop a comprehensive understanding of polarization phenomena, double refraction, Malus law, and Huygens' wave theory, enabling students to analyze and interpret the behavior of polarized light in various optical systems.

- **Proficiency in Analysis of Polarized Light**: Gain proficiency in analyzing polarized light using devices such as Nicol prisms, quarter-wave plates, and half-wave plates. Understand the production and detection of plane, circular, and elliptically polarized light.

- **Mastery of Fourier Analysis:** Master the concepts of Fourier series, Fourier coefficients, Fourier transforms, and their properties. Learn to apply Fourier analysis techniques to analyze and synthesize complex waveforms, including triangular and rectangular waves.

- **Application of Fourier Transforms:** Apply Fourier transform techniques to analyze functions and signals, including exponential and rectangular functions. Understand the properties and applications of Fourier transforms in various domains, such as signal processing, image analysis, and communication systems.

- **Proficiency in Geometrical Optics**: Develop proficiency in geometrical optics, including matrix methods, lens formula derivation, and analysis of optical aberrations. Understand the causes and remedies of chromatic aberration, spherical aberration, coma, astigmatism, and distortion, enabling the design of optical systems.

- **Understanding Fiber Optics Principles and Applications:** Gain a deep understanding of fiber optics principles, including critical angle of propagation, mode of propagation, numerical aperture, pulse dispersion, and attenuation. Learn about different types of optical fibers, their characteristics, and applications in communication systems, allowing students to design and implement fiber optic-based solutions effectively.

By the end of the course, students will have acquired a strong foundation in polarization, Fourier analysis, geometrical optics, and fiber optics, empowering them to analyze, design, and optimize optical and communication systems for various engineering and scientific applications

COURSE OUTCOMES:

After the successful completion of the course, students will be able to:

- Understand the theories and laws of polarization.
- Understanding of the production and detection of (i)Plane polarized light (ii)Circularly polarized light and (iii) Elliptically polarized light.
- Basic understanding about polarimeters.
- Learn the Fourier analysis of periodic functions.
- Applications of Fourier series and transform in physical problems.
- Proficiency in analyzing optical systems using matrix methods and applying thin lens formulae for design.
- Ability to identify and mitigate optical aberrations, ensuring high-quality image formation in optical systems.
- Have the idea of optical fibres and their properties.
- Principle of propagation of electromagnetic waves through optical fibres.
- Applications of optical fibers

Lesson Plan

Week No.	Scheduled Dates	Topic to be covered
1.	8th Jan 2024-13th Jan 2024	**Unit-1 Polarization:** Polarization (Basics- Definition polarized, Unpolarized, Plane of vibration. Plane of Polarization)
2.	15th Jan 2024-20th Jan 2024	Polarisation by reflection, Malus Law, Brewsters Law
3.	22th Jan 2024-27th Jan 2024	Polarization by scattering, , Phenomenon of double refraction,
4.	29th Jan 2024-3rd Feb 2024	Huygen's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light.
5.	5th Feb 2024- 10th Feb 2024	Nicol prism, Retardation Plates (Quarter wave plate and half wave plate)
6.	12th Feb 2024- 17th Feb 2024	Production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light
7.	19th Feb 2024- 24th Feb 2024	Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz). **Class Test, Doubts and Numericals of Unit-1**
8.	26th Feb 2024- 2nd March 2024	**Unit-2 Fourier analysis**: Fourier theorem and Fourier series, evaluation of Fourier coefficient, importance and limitations of Fourier theorem, even and odd functions
9.	4th March 2024-9th March 2024	Fourier series of functions f(x) between (i) 0 to 2pi, (ii) –pi to pi, (iii) 0 to pi, (iv) –L to L, complex form of Fourier series
10.	11th March 2024-16th March 2024	Application of Fourier theorem for analysis of complex waves: solution of triangular and rectangular waves , half and full wave rectifier outputs, Parseval identity for Fourier Series, Fourier integrals. **Class Test, Doubts and Numericals of Unit-1**
11.	18th March 2024-22nd March 2024	**Unit-3 Fourier Integrals:** Fourier transforms and its properties, Application of Fourier transform (i) for evaluation of integrals, (ii) for solution of ordinary differential equations Fourier transform of the following functions: 1. $f(x)= e^{-x^{2/2}}$ 1 <|X|<a 2 .f(x) = |x| 0 >|X |>a

	23rd March 2024 to 31st March 2024	Holi Break
12.	1st April 2024 to 6th April 2024	Matrix methods in paraxial optics, effects of translation and refraction, derivation of thin lens and thick lens formulae, unit plane, nodal planes, system of thin lenses **Doubts and Numericals of Unit-**3
13.	8th April 2024 to 13th April 2024	**Unit-IV** Chromatic, spherical, coma, astigmatism and distortion aberrations and their remedies
14.	15th April 2024 to 20th April 2024	Optical fiber, Critical angle of propagation, Mode of Propagation, Acceptance angle, Fractional refractive index change, Numerical aperture
15.	22th April 2024 to 27th April 2024	Types of optics fiber, Normalized frequency, Pulse dispersion, Attenuation, Applications of fiber optics, Fiber optic Communication **Doubts and Numericals of Unit-4**
16.	29th April 2024 and 30th April 2024	**Revision and Doubts and previous years question paper**