

Term: Spring 2000

Course #: OPTI 505

Course Title: Diffraction and Interferometry

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Office Hours: Call for appointment or see after class

Course Time on Campus: Tuesday/Thursday 8:00 - 9:15 AM

Prerequisites: Optics 501, 512

Course Description:

Interference and interferometry; concepts of coherence; holography; diffraction theory; Fraunhofer and Fresnel diffraction; volume diffraction; Gaussian beam propagation; optical transfer function; speckle.

Attached you will find a tentative outline, schedule, and recommended texts. You will be given two exams during the semester, plus a final exam. All exams will be in-class, closed book exams. The homework will be due at the beginning of the class on the date stated on each assignment sheet. Unless special permission is given to hand in homework late, credit will be reduced 25% for each day a homework assignment is late. The final grade in the course will be calculated as follows: homework - 20%; two exams - 40%; and final exam - 40%.

Optics 505 - Diffraction and Interferometry

1. Introduction to Theory of Interferometry and Diffraction
2. Maxwell's Equations
3. Wave Equation
 - 3.1 Transverse waves
 - 3.2 Plane waves
 - 3.3 Complex representation
 - 3.4 Spherical waves
 - 3.5 Linear superposition
 - 3.6 Polarization
4. Basic Interference
 - 4.1 Two plane waves
 - 4.2 Two spherical waves
 - 4.3 Plane wave and spherical wave
 - 4.4 Plane wave and cylindrical wave
 - 4.5 Methods of beam division
5. Concepts of Coherence
 - 5.1 Coherence time
 - 5.2 Coherence length
 - 5.3 Theory of partial coherence
 - 5.4 Fringe visibility reduction
 - 5.5 Fringe localization
 - 5.6 Correlation interferometry
6. Classical Two-Beam Interferometers
 - 6.1 Plane parallel plate
 - 6.2 Fizeau
 - 6.3 Michelson
 - 6.4 Twyman-Green
 - 6.5 Mach-Zehnder
 - 6.6 Lateral shear
 - 6.7 Radial shear
7. Multiple Beam Interference
 - 7.1 Airy's formula
 - 7.2 Absorbing coatings
 - 7.3 Fabry Perot (plane and spherical)
 - 7.4 FECO

8. Multilayer Films
 - 8.1 Theory
 - 8.2 AR film
 - 8.3 High reflectance film
9. Phase-Shifting Interferometry
 - 9.1 Methods of phase shifting
 - 9.2 Algorithms
10. Preliminary Description of Diffraction
11. Mathematical Description of Diffraction
 - 11.1 Helmholtz equation
 - 11.2 Green's theorem
 - 11.3 Integral theorem of Helmholtz and Kirchhoff
 - 11.4 Kirchhoff formulation of diffraction by a plane screen
 - 11.5 Kirchhoff boundary conditions
 - 11.6 Fresnel-Kirchhoff diffraction formula and Huygens-Fresnel principle
 - 11.7 Rayleigh-Sommerfeld formulation of diffraction by a plane screen
 - 11.8 Plane wave spectrum approach
 - 11.9 Babinet's principle
12. Fresnel and Fraunhofer Diffraction
 - 12.1 Fresnel approximation
 - 12.2 Fraunhofer diffraction
13. Fresnel Diffraction
 - 13.1 Fresnel zones
 - 13.2 Circular aperture
 - 13.3 Zone plate
 - 13.4 Rectangular aperture
 - 13.5 Large aperture - long slit and straight edge
 - 13.6 Talbot images
14. Fraunhofer Diffraction
 - 14.1 Single slit
 - 14.2 Rectangular aperture
 - 14.3 Circular aperture
 - 14.4 Double slit
 - 14.5 Multiple slits. Binary diffraction gratings
 - 14.6 Sinusoidal amplitude and phase gratings
15. Optical Transfer Function
 - 15.1 Coherent imaging
 - 15.2 Incoherent imaging
16. Gaussian Beams
 - 16.1 Basic theory
 - 16.2 Propagation through optical systems

17. Holography

17.1 Physical description

17.2 Mathematical proof of reconstruction process

17.3 Minimum reference beam angle to separate orders

17.4 Recording and playback geometry

17.5 Light sources and recording materials

17.6 Volume holograms

17.7 Applications

18. Speckle

18.1 Physical origin

18.2 Applications

J. C. Wyant
Spring, 2000

Optics 505
TENTATIVE SCHEDULE

<u>Lecture No.</u>	<u>Date</u>	<u>Section Covered</u>	<u>Homework due</u>
1	Jan. 13 (Th)	1, 2, 3	
2	Jan. 18 (Tu)	3	
3	Jan. 20 (Th)	3	
4	Jan. 25 (Tu)	4	HW #1: WP-3, WP-12, WP-17
5	Jan. 27 (Th)	4, 5	
6	Feb. 1 (Tu)	5	HW #2: I-2, I-4, I-11
7	Feb. 3 (Th)	5	
8	Feb. 8 (Tu)	5, 6	HW #3: C-5, C-10, C-18
9	Feb. 10 (Th)	6	
10	Feb. 15 (Tu)	7	HW #4: I-14, I-25, I-26
11	Feb. 17 (Th)	7, 8	
12	Feb. 22 (Tu)	8	HW #5: MB-1, MB-3, MB-9
13	Feb. 24 (Th)	Test Sections 1-7	
14	Feb. 29 (Tu)	9	
15	Mar. 2 (Th)	10, 11	HW #6: MB-5, DPM-1, DPM-4
16	Mar. 7 (Tu)	11	
17	Mar. 9 (Th)	11, 12	HW #7: D-1, D-2, D-5
18	Mar. 21 (Tu)	12, 13	
19	Mar. 23 (Th)	13	HW #8: D-6, D-7, D-11
20	Mar. 28 (Tu)	13	

21	Mar. 30 (Th)	14	HW #9: D-15, D-17, D-24

22	Apr. 4 (Tu)	14	
23	Apr. 6 (Th)	Test Sections 8 - 13	

24	Apr. 11 (Tu)	15	HW #10: D-26, D-27, D-28
25	Apr. 13 (Th)	16	

26	Apr. 18 (Tu)	16, 17	HW #11: D-29, D-31, D-37
27	Apr. 20 (Th)	17	

28	Apr. 25 (Tu)	17	HW #12: D-39, HS-1, HS-3
29	Apr. 27 (Th)	18	

30	May 2 (Tu)	18	HW #13: HS-5, HS-10, HS-11

References - OPTI 505 - Diffraction and Interferometry

Primary

Born & Wolf	Principles of Optics
Goodman	Introduction to Fourier Optics
Hecht	Optics

Secondary

Collier, Burckhardt, & Lin	Optical Holography
Dainty	Laser Speckle and Related Phenomena
Ditchburn	Light
Francon	Optical Interferometry
Francon & Mallick	Polarization Interferometers
Francon et al.	Atlas of Optical Phenomena and Supplement
Goodman	Statistical Optics
Hariharan	Optical Interferometry
Hariharan	Optical Holography
Hariharan	Basics of Interferometry
Jenkins & White	Fundamentals of Optics
Jones & Wykes	Holographic and Speckle Interferometry
Klein & Furtak	Optics
Mertz	Transformations in Optics
Möller	Optics
Reynolds, DeVelis, Parrent, and Thompson	Physical Optics Notebook: Tutorials in Fourier Optics

Saleh and Teich	Fundamentals of Photonics
Scott	Introduction to Optics and Optical Imaging
Steel	Interferometry
Stone	Radiation and Optics
Tolansky	Multiple-Beam Interferometry of Surfaces and Films
Vest	Holographic Interferometry