



CREOL OSE 6120: Theoretical Foundations of Optics

College of Optics and Photonics, Spring 2020
University of Central Florida

COURSE SYLLABUS

Instructor:	Dr. Miguel A. Bandres	Term:	FALL 2020
Office:	A222	Class Meeting Days:	Monday/Wednesday
		Class Meeting Hours:	4:30pm-5:45pm
E-Mail:	bandres@creol.ucf.edu	Class Location:	ZOOM
Office Hours:	Thursday 2:30pm-3:30pm	Lab Location:	No Lab

Additional Note: Office hours are planned for Thursday 2:30pm-3:30pm, but of course I will be happy to discuss the material with you anytime. Please send me an email if you would like to schedule a meeting.

I. University Course Catalog Description

Mathematical concepts used in Optics. Topics covered include linear algebra, orthogonal expansions of functions, Fourier transforms, ordinary differential equations, and partial differential equations.

II. Course Overview

This course aims to provide graduate students with common mathematical concepts used in Optics. The emphasis will be in practical understanding the mathematical concepts to effectively use them as tools to study Optics. The topics to be covered (in a context related to Optics) are: linear algebra, orthogonal expansions, Fourier theory, ordinary differential equations, partial differential equations. **See the list full of the topics at the end.**

III. Course Prerequisites

Graduate standing or consent of instructor.

IV. Course Credits

3 Credit hours.

V. Required Texts and Materials

No textbook required. Notes will be provided for relevant topic.

VI. Supplementary (Optional) Texts and Materials

Before each topic I will give a list of specific reference for that topic. But in general the following books are a good in case you need extra references:

G. J. Gbur, "Mathematical Methods for Optical Physics and Engineering," Cambridge University, 2011.

M. Mansuripur, Mathematical Methods in Science and Engineering (Applications in Optics and Photonics) Cognella Academic Publishing, 2018

G. B. Arfken and H. J. Weber, "Mathematical Methods for Physicists," Academic Press, 2005.

VII. Basis for Final Grade

Assessment	Percent of Final Grade
Homework (~12 assignments)	90%
Final take-home exam	10%
	100%

Homework is due 1 week after assigned. The lowest graded homework will be dropped.

I expect you to work independently on the homework and then you can discuss just verbally (not showing your homework or explicit calculations/procedures) with your colleagues.

Final take-home exam **must be done independently**, and is due 1 week after assigned.

Grading Scale (%)	
90-100	A
80 - 89	B
70 - 79	C
60 - 69	D
0 - 59	F

VIII. Grade Dissemination

Graded tests and materials in this course will be returned individually and not posted publicly. You can access your scores at any time using "myUCF Grades" in the portal. Please note that scores returned mid-semester are unofficial grades. If you need help accessing myUCF Grades, see the online tutorial: <https://myucfgrades.ucf.edu/help/>.

IX. Course Policies: Grades

Late Work Policy:

There are **no** make-ups for take-home final exam. Homework turned in late will be assessed a penalty: 7% will be deducted for each day late, and will not be accepted if overdue by more than 6 days.

Extra Credit Policy:

The homework (one) with the lowest grade will not count for the final grade.

Grades of "Incomplete":

The current university policy concerning incomplete grades will be followed in this course. Incomplete grades are given only in situations where unexpected emergencies prevent a student from completing the course and the remaining work can be completed the next semester. Your instructor is the final authority on whether you qualify for an incomplete. Incomplete work must be finished by the end of the subsequent semester or the "I" will automatically be recorded as an "F" on your transcript.

X. Course Policies: Technology and Media

Email: Feel free to email me regarding any question or concern about the class or to request a meeting.

Classroom Devices: Recording audio or video of the class it is not allow.

XI. Course Policies: Student Expectations

Disability Access:

The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. This syllabus is available in alternate formats upon request. Students who need accommodations must be registered with Student Disability Services, Ferrell Commons Room 185, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor.

Attendance Policy:

Regular class attendance is required in this course and is necessary for students to understand many of the topics covered. Students must be on time to class. If missed a class, it is the responsibility of the student to find out the materials covered.

Financial Aid and Attendance:

Students' academic activity at the beginning of each course must be documented. In order to document that you began this course, **students must complete the academic participation verification question** posted on Webcourses no later than a week after the first class. Failure to do so will result in a delay in the disbursement of financial aid.

Academic Conduct Policy:

Academic dishonesty in any form will not be tolerated. If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule, the University of Central Florida's Student Handbook (<http://www.goldenrule.sdes.ucf.edu/>) for further details. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University

XII. Important Dates to Remember

All the dates and assignments are tentative, and can be changed at the discretion of the professor.

Drop/Swap Deadline:	Fri, August 28 th 2020
Grade Forgiveness Deadline:	Fri, December 4 th 2020
Withdrawal Deadline:	Fri, October 30 th 2020
Thanksgiving:	Thu, Nov 26 th – Sat, Nov 28 th
Final take-home Exam due:	Fri, December 4 th 2020

Calendar:

August (3) / September (8)		October (8)		November (8)		December (3)	
24	26	5	7	2	4		2
31	2	12	14	9	11 Veterans Day	7	10
7 Labor Day	9	19	21	16	18		
14	16	26	28	23	25		
21	23			30			
28	30						

XIII. List of Topics

1. Linear Algebra.

1. Linear vector spaces
2. Linear and bi-linear operators
 1. Scalar (Dot) Product
 2. Symmetric and Orthogonal operators
 3. Hermitian and Unitary operators
3. Eigenvalues and eigenvectors of a linear operator
 1. Diagonalization and Completeness of the system of eigenvectors
4. Matrices, powers of matrices and functions of matrices
5. Non-Hermitian operators

2. Orthogonal Expansions

1. Linear space of functions
2. Scalar product of function
3. Orthogonal polynomials and completeness
4. Expansions of functions

3. Fourier Theory

1. Fourier series and convergence
2. Fourier transform and its inverse
3. Dirac Delta Function
4. Properties of the Fourier transform
5. Eigenfunctions of the Fourier transform
6. 2D Fourier transform and Hankel transform
7. Discrete Fourier transform
8. Fast Fourier Transform, advantages and dangers
9. Sampling Theory
10. Compress sensing (basic concepts)

4. Ordinary Differential Equations

1. Linear ODEs
2. Diffusion equation
3. 1D wave equation
4. Boundary Conditions
5. Series Solutions / Integral Transforms
6. WKB approximation
7. Integral transform solution
8. System of differential equations
9. Driving systems
10. Nonlinear ODEs
11. Invariances/Symmetries in ODES

5. Partial Differential Equations (PDEs)

1. Helmholtz Equation
 1. Coordinate systems
 2. Separation of variables: plane waves, spherical waves, cylindrical waves.
 3. Non-diffractive solutions
 4. Green's function: exact and approximate Huygens' principle
2. Paraxial wave equation
 1. Approximation
 2. Separation of variables
 3. Hermite, Laguerre Gaussian beams
 4. Airy beams

6. Group Symmetries

1. Definition and properties
2. Rotational group
3. ABCD paraxial transformations

Religious Observances

Students are expected to notify their instructor in advance if they intend to miss class to observe a holy day of their religious faith. For a current schedule of major religious holidays, see the Faculty Center's main web page under "Calendars," and for additional information, contact the Office of Diversity Initiatives at 407-823-6479.