



Edit

[Jesse Wilson](#)

Logout

[\(https://it.colostate.edu/single-sign-on/\)](https://it.colostate.edu/single-sign-on/)

# ECE 502- Advanced Fourier Optics

## Course Details

Instructor: Jesse W. Wilson

Course developed by: Randy A. Bartels

Office: 324 Scott Bioengineering

Office Hours: By appointment

E-mail: [jesse.wilson@colostate.edu](mailto:jesse.wilson@colostate.edu)

Phone: (970) 491-3706

## Both the ECE 457 Lectures and the ECE 502 Weekly Lecture

**ECE 457 Lecture:** 11:00 am - 12:15 pm , Tu/Th Scott 231

**ECE 502 Lecture:** 1:00 pm - 1:10 pm , M Scott 231

Online lecture posted by 5:00 pm

ECE502 Lecture MS Teams livestream link: [https://teams.microsoft.com/L/meetup-join/19%3aATHqykjw4SDZ6QyxQMx\\_o36CwiMwbxbwq4kl37HUGY1%40thread.tacv2/1704749084098?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d%22%7d](https://teams.microsoft.com/L/meetup-join/19%3aATHqykjw4SDZ6QyxQMx_o36CwiMwbxbwq4kl37HUGY1%40thread.tacv2/1704749084098?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d%22%7d)

[https://teams.microsoft.com/L/meetup-join/19%3aATHqykjw4SDZ6QyxQMx\\_o36CwiMwbxbwq4kl37HUGY1%40thread.tacv2/1704749084098?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d%22%7d](https://teams.microsoft.com/L/meetup-join/19%3aATHqykjw4SDZ6QyxQMx_o36CwiMwbxbwq4kl37HUGY1%40thread.tacv2/1704749084098?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d%22%7d)

## Course Description

The objective of this course is to provide students with a fundamental background in the Fourier Optics description of light propagation, diffraction, and use in imaging systems and will learn to model diffraction and imaging optical systems. Students will also learn to make use of the forward Fourier Optics models for solving inverse computational imaging problems. Successful students will be able to design and analyze optical imaging and computational imaging systems, as well as design, produce, and implement

forward numerical optical models and to computationally invert those models to solve for underlying objects using inverse methods. The students will also learn how these sophisticated computational imaging tools are being used to solve complex problems in diverse fields such as biomedical, industrial, consumer, x-ray science, materials science, and security imaging applications.

## Textbook

Mathematica for students: <https://www.wolfram.com/mathematica/pricing/students/>   
(<https://www.wolfram.com/mathematica/pricing/students/>)

***There is a single semester option***

AND

***Introduction to Optical Microscopy***

by Jerome Mertz

Cambridge University Press

July 2019

**ISBN-10:** 1108428304

**ISBN-13:** 978-1108428309

DOI: <https://doi.org/10.1017/9781108552660>  (<https://doi.org/10.1017/9781108552660>)

<https://www.cambridge.org/core/books/introduction-to-opticalmicroscopy/F6C6318C87732519D7E07BA7A03F0B81>   
(<https://www.cambridge.org/core/books/introduction-to-opticalmicroscopy/F6C6318C87732519D7E07BA7A03F0B81>)

AND

***Principles of Scattering and Transport of Light***

by Rémi Carminati, ESPCI, Paris, John C. Schotland, Yale University, Connecticut

Cambridge University Press

July 2021

**ISBN:** 9781316544693

CSU Access Link: [Principles of Scattering and Transport of Light](#) 

([https://nam10.safelinks.protection.outlook.com/?](https://nam10.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cambridge.org%2Fcore%2Fbooks%2Fprinciples-of-scattering-and-transport-of-light%2F72B09D4FBD26689DC3D49BDB4436E7FA&data=04%7C01%7Crbartels%40rams.colostate.edu%7C4)

[url=https%3A%2F%2Fwww.cambridge.org%2Fcore%2Fbooks%2Fprinciples-of-scattering-and-transport-of-light%2F72B09D4FBD26689DC3D49BDB4436E7FA&data=04%7C01%7Crbartels%40rams.colostate.edu%7C4](https://nam10.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cambridge.org%2Fcore%2Fbooks%2Fprinciples-of-scattering-and-transport-of-light%2F72B09D4FBD26689DC3D49BDB4436E7FA&data=04%7C01%7Crbartels%40rams.colostate.edu%7C4)

<https://nam10.safelinks.protection.outlook/?url=https%3A%2F%2Fwww.cambridge.org%2Fcore%2Fbooks%2Fprinciples-of-scattering-and-transport-of-light%2F72B09D4FBD26689DC3D49BDB4436E7FA&data=04%7C01%7Crbartels%40rams.colostate.edu%7C4>

**Principles of Scattering and Transport of Light (cambridge.org)**

<https://www.cambridge.org/core/books/principles-of-scattering-and-transport-of-light/72B09D4FBD26689DC3D49BDB4436E7FA>

Course Schedule

Google calendar link: <https://calendar.google.com/calendar/embed?src=15bf8c04171d0bd7efcd96d336da92681f3cc9cc6033c9320b3f971c7eb646fb%40group.calendar.google.com>

<https://calendar.google.com/calendar/embed?src=15bf8c04171d0bd7efcd96d336da92681f3cc9cc6033c9320b3f971c7eb646fb%40group.calendar.google.com>

**ECE502 FA2024**

Today

January 2024

Print

Week

Month

Agenda

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	Jan 1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	Feb 1	2	3



<b>Week</b>	<b>Topic</b>	<b>Preparation for Class</b>	<b>Assignments Due</b>
Week 1	L01 - Introduction and Overview of Computational Imaging	Read papers in the module Lecture 01 Slides	
Week 2	L02 - Review of wave propagation, scalar scattering, and coherent imaging	Read papers in the module Lecture 02 Slides	
Week 3	L03 - Iterative Phase Retrieval	Read papers in the module Lecture 03 Slides	
Week 4	L04 - Wigner Optics	Read papers in the module Lecture 04 Slides	
Week 5	L05 - Transport of Intensity Equation	Read papers in the module Lecture 05 Slides	
Week 6	L06 - Ptychographic imaging	Read papers in the module Lecture 06 Slides	
Week 7	L07 - Ptychographic imaging in phase space	Read papers in the module Lecture 07 Slides	
Week 8	L08 - Polarized scattering	Read papers in the module	


		Lecture 08 Slides	
Week 9	<b>Spring Break</b>	<b>Spring Break</b>	<b>Spring Break</b>
Week 10	L09 - Quantitative imaging of single particle polarizability	Read papers in the module Lecture 09 Slides	
Week 11	L10 - Coded aperture imaging	Read papers in the module Lecture 10 Slides	
Week 12	L11 - Lightfield imaging	Read papers in the module Lecture 11 Slides	
Week 13	L12 - Scattering light and imaging in phase space	Read papers in the module Lecture 12 Slides	
Week 13	L13 - Computational Imaging with Speckle Fluctuations	Read papers in the module Lecture 13 Slides	
Week 15	L14 - Computational phase contrast microscopy	Read papers in the module Lecture 14 Slides	
Week 16	L15 - Computational super-resolution microscopy	Read papers in the module Lecture 15 Slides	

## Software



Mathematica or MATLAB is required for this course.


## Mathematica Tutorials


**Nice Book:** <https://arxiv.org/pdf/1403.7050.pdf>  (<https://arxiv.org/pdf/1403.7050.pdf>)   
[https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=https%3A%2F%2Farxiv.org%2Fpdf%2F1403.7050.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=https%3A%2F%2Farxiv.org%2Fpdf%2F1403.7050.pdf)

**Wolfram site:** <https://www.wolfram.com/language/fast-introduction-for-math-students/en/>   
<https://www.wolfram.com/language/fast-introduction-for-math-students/en/>

<https://pages.mtu.edu/~msgocken/pdebook2/mathtut2.pdf>   
<https://pages.mtu.edu/~msgocken/pdebook2/mathtut2.pdf>   
[https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=https%3A%2F%2Fpages.mtu.edu%2F~msgocken%2Fpdebook2%2Fmathtut2.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=https%3A%2F%2Fpages.mtu.edu%2F~msgocken%2Fpdebook2%2Fmathtut2.pdf)

<http://www2.eng.ox.ac.uk/~labejp/Seminar/Mathematica/MathematicaSeminarNotes.pdf>   
<http://www2.eng.ox.ac.uk/~labejp/Seminar/Mathematica/MathematicaSeminarNotes.pdf>   
[https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=http%3A%2F%2Fwww2.eng.ox.ac.uk%2F~labejp%2FSeminar%2FMathematica%2FMathematicaSeminarNotes.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=http%3A%2F%2Fwww2.eng.ox.ac.uk%2F~labejp%2FSeminar%2FMathematica%2FMathematicaSeminarNotes.pdf)

<https://www.cfm.brown.edu/people/dobrush/am33/Mathematica/index.html>   
<https://www.cfm.brown.edu/people/dobrush/am33/Mathematica/index.html>

<https://www.cfm.brown.edu/people/dobrush/am34/Mathematica/index.html>   
<https://www.cfm.brown.edu/people/dobrush/am34/Mathematica/index.html>

<https://mresources.github.io/tutorial/>  (<https://mresources.github.io/tutorial/>)

<https://site.uvm.edu/mathematica/>  (<https://site.uvm.edu/mathematica/>)

<https://people.math.harvard.edu/computing/math/tutorial/index.html>   
<https://people.math.harvard.edu/computing/math/tutorial/index.html>

<https://tutorial.math.lamar.edu/>  (<https://tutorial.math.lamar.edu/>)

[https://12000.org/my\\_notes/faq/mma\\_notes/MMA.htm](https://12000.org/my_notes/faq/mma_notes/MMA.htm)   
[https://12000.org/my\\_notes/faq/mma\\_notes/MMA.htm](https://12000.org/my_notes/faq/mma_notes/MMA.htm)


<https://courses.washington.edu/ph227814/228/nb/>   
<https://courses.washington.edu/ph227814/228/nb/>

## Online Resources

# Biology and Biological Optics Resources

Lectures on biology and techniques: <https://www.ibiology.org/biology-online/>   
(<https://www.ibiology.org/biology-online/>)

Quantitative Biological Imaging (good lectures): <https://www.quantitativebioimaging.com/>  
(<https://www.quantitativebioimaging.com/>)

Biology numbers: <https://bionumbers.hms.harvard.edu/search.aspx>   
(<https://bionumbers.hms.harvard.edu/search.aspx>)

Biology numbers: <http://book.bionumbers.org>  (<http://book.bionumbers.org>)


## Optics and Physics Resources

Online optics textbook: <https://optics.byu.edu/home>  (<https://optics.byu.edu/home>)

Online physics textbook: <https://opentextbc.ca/universityphysicsv3openstax/>   
(<https://opentextbc.ca/universityphysicsv3openstax/>)

Hyperphysics: <http://hyperphysics.phy-astr.gsu.edu/hbase/index.html>  (<http://hyperphysics.phy-astr.gsu.edu/hbase/index.html>)

Introduction to Scattering:

<https://www.youtube.com/watch?v=IU-QEm-2hFs>  (<https://www.youtube.com/watch?v=IU-QEm-2hFs>)



(<https://www.youtube.com/watch?v=IU-QEm-2hFs>)

<https://www.youtube.com/watch?v=f6sHn3pyAro>  (<https://www.youtube.com/watch?v=f6sHn3pyAro>)



(<https://www.youtube.com/watch?v=f6sHn3pyAro>)

Optical Diffraction Tomography:

<https://youtu.be/fh7AfGzQ1Uw>  (<https://youtu.be/fh7AfGzQ1Uw>)




(<https://youtu.be/fh7AfGzQ1Uw>)

Virtual photonics: <https://virtualphotonics.org/>  (<https://virtualphotonics.org/>)


Scattering and absorption spectroscopy: <https://omlc.org/~prahl/>  (<https://omlc.org/~prahl/>)

NIST chemistry and spectroscopy database: <https://webbook.nist.gov/chemistry/>  (<https://webbook.nist.gov/chemistry/>)

Thorlabs technical guides: [https://www.thorlabs.com/navigation.cfm?guide\\_id=2474](https://www.thorlabs.com/navigation.cfm?guide_id=2474)  ([https://www.thorlabs.com/navigation.cfm?guide\\_id=2474](https://www.thorlabs.com/navigation.cfm?guide_id=2474))

## Computational Imaging

Computational Imaging Lecture Series: <https://sites.google.com/view/sps-space>  (<https://sites.google.com/view/sps-space>)

Diffuse Optical Spectroscopic Imaging (DOSI): <https://vimeo.com/88174807>  (<https://vimeo.com/88174807>)

Diffuse Imaging:  
<https://www.youtube.com/watch?v=fKMghVWOoA0>  (<https://www.youtube.com/watch?v=fKMghVWOoA0>)



(<https://www.youtube.com/watch?v=fKMghVWOoA0>)

Spatial Frequency Domain Imaging:  
<https://www.youtube.com/watch?v=l3l9-pfLI4o>  (<https://www.youtube.com/watch?v=l3l9-pfLI4o>)



(<https://www.youtube.com/watch?v=l3l9-pfLI4o>)



**Light Field Imaging:**

[https://www.youtube.com/watch?v=THzykL\\_BLLI](https://www.youtube.com/watch?v=THzykL_BLLI)  ([https://www.youtube.com/watch?v=THzykL\\_BLLI](https://www.youtube.com/watch?v=THzykL_BLLI))



([https://www.youtube.com/watch?v=THzykL\\_BLLI](https://www.youtube.com/watch?v=THzykL_BLLI))

## Microscope (and optics) Resources

Olympus Microscope Resource Center: <https://www.olympus-lifescience.com/en/microscope-resource/> (<https://www.olympus-lifescience.com/en/microscope-resource/>)

Nikon MicroscopyU: <https://www.microscopyu.com/> (<https://www.microscopyu.com/>)

UofA Microscopy Resources: <https://microscopy.arizona.edu/learn/microscopy-imaging-resources-www> (<https://microscopy.arizona.edu/learn/microscopy-imaging-resources-www>)

ImageJ: <https://imagej.nih.gov/ij/> (<https://imagej.nih.gov/ij/>)

Molecular Expressions Primer: <https://micro.magnet.fsu.edu/primer/> (<https://micro.magnet.fsu.edu/primer/>)

Royal Microscopical Society: <https://www.rms.org.uk/study-read/news-listing-page/online-microscopy-talks-list.html>  (<https://www.rms.org.uk/study-read/news-listing-page/online-microscopy-talks-list.html>)

Fluorescence tutorials: <https://www.thermofisher.com/us/en/home/support/tutorials.html>  (<https://www.thermofisher.com/us/en/home/support/tutorials.html>)

### Weekly Canvas Quizzes

There will be a weekly quiz on Canvas. For this quiz, you will answer several questions that require either a numerical answer or a formula answer. You will have infinite attempts at providing the answer so that, hopefully, everyone is successful with these quizzes. In addition to the answer, you will need to upload a written out answer that explains how you computed your result(s) for the quiz solution as part of the homework assignments. Details of the formatting requirements for homework are provided below.

### Software

Mathematica is highly recommended for this course.

## Assignments and Canvas

I will post all assignments on Canvas, and all assignments must be submitted through Canvas.

All assignments will be submitted as a pdf file and will be prepared either in Mathematica, LaTeX, or a similar program so that all responses are typeset. All code used for calculation must be submitted in the pdf.

It is expected that you will use the following format for submitting all assignments:

LAST.FIRST.ASSIGNMENT.pdf                      For example: Bartels.Randy.HW01.pdf

## Homework Policy

The homework is an essential part of the course. You should attempt all problems yourself, but feel free to argue with your colleagues about them. (Simply copying each other's solutions is, however, counterproductive for all parties and is not acceptable.

A few of the problems will be numerical, not involving heavy computation, but more in the way of modeling pulse propagation through various dispersive elements, so you will need to use your favorite math package (e.g., Mathcad, Maple, Matlab, Mathematica, IDL, etc.).

To clarify, a homework solution MUST include a full explanation of how the problem is set up, the motivation of steps in the analysis, and an interpretation of the results. The entire point of homework is to explore and think about the material presented in the class AND to be able to communicate your findings. The ability to communicate scientific ideas is of critical importance. Moreover, the emphasis of homework is to analyze each physical situation, interpret that analysis, and communicate the meaning. As a result, the emphasis is NOT on algebraic manipulations.

You are encouraged to use Mathematica (and to a MUCH lesser extent other mathematical tools) to write up your solution. All solutions MUST be in a highly simplified form that YOU interpret correctly. Remember: each homework solution should be a short story that includes a reproduction of appropriate diagrams and may require plots of the final solutions you find to explain behaviors.

## Homework Formatting Requirements

All homework assignments must be submitted in narrative form. Consider each answer a short essay or paper. In all instances, you should provide a quick background and motivation in the context of Optical Microscopy and then develop your answer to the questions while explaining each step. Below are notes on writing and formatting requirements:

These notes are adapted from Stephen Boyd et al.:

[https://web.stanford.edu/class/ee364b/latex\\_templates/template\\_notes.pdf](https://web.stanford.edu/class/ee364b/latex_templates/template_notes.pdf)

[https://web.stanford.edu/class/ee364b/latex\\_templates/template\\_notes.pdf](https://web.stanford.edu/class/ee364b/latex_templates/template_notes.pdf) 

<https://docreader.readspeaker.com/docreader/?>

[cid=11403&lang=en\\_us&url=https%3A%2F%2Fweb.stanford.edu%2Fclass%2Fee364b%2Flatex\\_templates%2](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=https%3A%2F%2Fweb.stanford.edu%2Fclass%2Fee364b%2Flatex_templates%2)

You will likely find that when you write out a detailed explanation on a question, you will find that there are gaps in your understanding and thought process. The process of writing out a full explanation will help you clarify your thought and understanding.

John von Neumann once said, “There’s no sense in being precise when you don’t even know what you’re talking about,” and Niels Bohr wrote, “Never express yourself more clearly than you can think.” Keep these in mind.

**Write in good English:** Always write good English, even when the subject that you are discussion contains mathematics. This includes correct grammar, word choice, punctuation, spelling, phrasing, and common sense. A classic on this topic, only slightly dated, is Strunk and White [1].

**Keep the reader in mind:** Perhaps the most important principle of good writing is to keep the reader in mind: What do they know so far? What do they expect next and why? Do they have sufficient motivation for stated results? As part of this, make sure you know what level of reader you are writing for and stay consistent with that level. If the reader is expected to know microscopy, do not keep defining standard concepts like numerical aperture (you will know this well before the end of the course if you don’t already know about this)!

**Write to allow skipping over formulas:** Many readers will first read through the paper ignoring or skipping all but the simplest formulas. Your sentences and overall report should flow smoothly, and make sense, when all but the simplest formulas are replaced by “blah” or a similar placeholder. As a related point, do not simply display a list of formulas or equations in a row; tie the concepts together with a running commentary.

## Online Course Details

All lectures will be available online and simultaneous participation will be available with Zoom.

## Late Policy


You are expected to manage your schedule and meet all assigned deadlines. Items turned in within 24 hours after a deadline will receive a 25% penalty. Items turned in 24-48 hours late will receive a 50% penalty. Items submitted more than 48 hours late will not be accepted. Any exceptions must be approved in advance. Late submission is not allowed for the final exam.

## Honor Pledge

For all work in this course, it is assumed that the following statement is true: I will not give, receive, or use any unauthorized assistance. The exception is that students may discuss approaches

and clarifications regarding homework problems. In fact, this is highly encouraged and you may learn a lot from your peers and from helping your peers.

## Professionalism and Academic integrity

This course will adhere to the CSU Academic Integrity Policy as found on the Student' Responsibilities page of the **CSU General Catalog** (<http://catalog.colostate.edu/general-catalog/policies/students-responsibilities/#academic-integrity>) and in the **Student Conduct Code**.  
(<https://resolutioncenter.colostate.edu/wp-content/uploads/sites/32/2018/08/Student-Conduct-Code-v2018.pdf>)  ([https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=https%3A%2F%2Fresolutioncenter.colostate.edu%2Fwp-content%2Fuploads%2Fsites%2F32%2F2018%2F08%2FStudent-Conduct-Code-v2018.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=https%3A%2F%2Fresolutioncenter.colostate.edu%2Fwp-content%2Fuploads%2Fsites%2F32%2F2018%2F08%2FStudent-Conduct-Code-v2018.pdf))


For more details on academic integrity, please read **Practicing Academic Integrity**.  
(<http://learning.colostate.edu/integrity/index.cfm>)

At a minimum, violations will result in a grading penalty in this course and a report to the Office of Student Resolution Center.

## References



[1] W. Strunk and E. White. The Elements of Style. Macmillan, 1957.

## Matlab and Tutorials



**CSU Matlab install (and tutorials):** <https://www.mathworks.com/academia/tah-portal/colorado-state-university-40638290.html>  (<https://www.mathworks.com/academia/tah-portal/colorado-state-university-40638290.html>)

**A list of tutorials:** <http://engineering.nyu.edu/mechatronics/vkapila/matlabtutor.html>  (<http://engineering.nyu.edu/mechatronics/vkapila/matlabtutor.html>)

**Matlab tutorials for image processing:**

[http://www.audentia-gestion.fr/Matlab/Matlab-Image\\_Processing\\_Tutorial.pdf](http://www.audentia-gestion.fr/Matlab/Matlab-Image_Processing_Tutorial.pdf)   
([http://www.audentia-gestion.fr/Matlab/Matlab-Image\\_Processing\\_Tutorial.pdf](http://www.audentia-gestion.fr/Matlab/Matlab-Image_Processing_Tutorial.pdf))   
([https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=http%3A%2F%2Fwww.audentia-gestion.fr%2FMatlab%2FMatlab-Image\\_Processing\\_Tutorial.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=http%3A%2F%2Fwww.audentia-gestion.fr%2FMatlab%2FMatlab-Image_Processing_Tutorial.pdf))

<http://apps.usd.edu/coglab/schieber/psyc707/pdf/2D-FFT.pdf>   
(<http://apps.usd.edu/coglab/schieber/psyc707/pdf/2D-FFT.pdf>)   
([https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=http%3A%2F%2Fapps.usd.edu%2Fcoglab%2Fschieber%2Fpsyc707%2Fpdf%2F2D-FFT.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=http%3A%2F%2Fapps.usd.edu%2Fcoglab%2Fschieber%2Fpsyc707%2Fpdf%2F2D-FFT.pdf))

<http://apps.usd.edu/coglab/schieber/psyc707/pdf/2D-FFT.pdf>   
(<http://apps.usd.edu/coglab/schieber/psyc707/pdf/2D-FFT.pdf>)   
([https://docreader.readspeaker.com/docreader/?cid=11403&lang=en\\_us&url=http%3A%2F%2Fapps.usd.edu%2Fcoglab%2Fschieber%2Fpsyc707%2Fpdf%2F2D-FFT.pdf](https://docreader.readspeaker.com/docreader/?cid=11403&lang=en_us&url=http%3A%2F%2Fapps.usd.edu%2Fcoglab%2Fschieber%2Fpsyc707%2Fpdf%2F2D-FFT.pdf))

[http://mstrzel.elel.p.lodz.pl/mstrzel/pattern\\_rec/fft\\_ang.pdf](http://mstrzel.elel.p.lodz.pl/mstrzel/pattern_rec/fft_ang.pdf) 

([http://mstrzel.elel.p.lodz.pl/mstrzel/pattern\\_rec/fft\\_ang.pdf](http://mstrzel.elel.p.lodz.pl/mstrzel/pattern_rec/fft_ang.pdf)) 

(<https://docreader.readspeaker.com/docreader/?>

[cid=11403&lang=en\\_us&url=http%3A%2F%2Fmstrzel.elel.p.lodz.pl%2Fmstrzel%2Fpattern\\_rec%2Ffft\\_ang.pdf](cid=11403&lang=en_us&url=http%3A%2F%2Fmstrzel.elel.p.lodz.pl%2Fmstrzel%2Fpattern_rec%2Ffft_ang.pdf)

[http://users.cs.cf.ac.uk/Dave.Marshall/CM2208/LECTURES/CM2208\\_Fourier\\_Transforms\\_01\\_Theory.pdf](http://users.cs.cf.ac.uk/Dave.Marshall/CM2208/LECTURES/CM2208_Fourier_Transforms_01_Theory.pdf)

 ([http://users.cs.cf.ac.uk/Dave.Marshall/CM2208/LECTURES/CM2208\\_Fourier\\_Transforms\\_01\\_Theory.pdf](http://users.cs.cf.ac.uk/Dave.Marshall/CM2208/LECTURES/CM2208_Fourier_Transforms_01_Theory.pdf))

 (<https://docreader.readspeaker.com/docreader/?>

[cid=11403&lang=en\\_us&url=http%3A%2F%2Fusers.cs.cf.ac.uk%2FDave.Marshall%2FCM2208%2FLECTURES%2Fcm2208%2Ffourier%2Ftransforms%2F01%2Ftheory.pdf](cid=11403&lang=en_us&url=http%3A%2F%2Fusers.cs.cf.ac.uk%2FDave.Marshall%2FCM2208%2FLECTURES%2Fcm2208%2Ffourier%2Ftransforms%2F01%2Ftheory.pdf)

## Mathematica Tutorials

**Wolfram site:** <https://www.wolfram.com/language/fast-introduction-for-math-students/en/> 

(<https://www.wolfram.com/language/fast-introduction-for-math-students/en/>)

<https://pages.mtu.edu/~msgocken/pdebook2/mathtut2.pdf> 

(<https://pages.mtu.edu/~msgocken/pdebook2/mathtut2.pdf>) 

(<https://docreader.readspeaker.com/docreader/?>

[cid=11403&lang=en\\_us&url=https%3A%2F%2Fpages.mtu.edu%2F~msgocken%2Fpdebook2%2Fmathtut2.pdf](cid=11403&lang=en_us&url=https%3A%2F%2Fpages.mtu.edu%2F~msgocken%2Fpdebook2%2Fmathtut2.pdf)

<http://www2.eng.ox.ac.uk/~labejp/Seminar/Mathematica/MathematicaSeminarNotes.pdf> 

(<http://www2.eng.ox.ac.uk/~labejp/Seminar/Mathematica/MathematicaSeminarNotes.pdf>) 

(<https://docreader.readspeaker.com/docreader/?>

[cid=11403&lang=en\\_us&url=http%3A%2F%2Fwww2.eng.ox.ac.uk%2F~labejp%2FSeminar%2FMathematica%2FMathematicaSeminarNotes.pdf](cid=11403&lang=en_us&url=http%3A%2F%2Fwww2.eng.ox.ac.uk%2F~labejp%2FSeminar%2FMathematica%2FMathematicaSeminarNotes.pdf)

## Course Information

Canvas is the where course content, grades, and communication will reside for this course.


Login: [canvas.colostate.edu](https://canvas.colostate.edu/)  (<http://canvas.colostate.edu/>)


Support: [info.canvas.colostate.edu](https://canvas.colostate.edu/support/)  (<https://canvas.colostate.edu/support/>)

For passwords or any other computer-related technical support, contact the [Central IT Technical Support Help Desk](http://lib.colostate.edu/services/computers/technical-support-helpdesk/)  (<http://lib.colostate.edu/services/computers/technical-support-helpdesk/>).

Voice: (970) 491-7276


Email: [help@colostate.edu](mailto:help@colostate.edu) (<mailto:help@colostate.edu>)

The [Technical Requirements](https://www.online.colostate.edu/current-students/technical-support-and-requirements/)  (<https://www.online.colostate.edu/current-students/technical-support-and-requirements/>) page identifies the browsers, operating systems, and plugins that work best with Canvas.

Further information about Academic Integrity is available at CSU's [Academic Integrity - Student Resources](https://tilt.colostate.edu/Integrity/StudentResources/)  (<https://tilt.colostate.edu/Integrity/StudentResources/>).

Universal Design for Learning/Accommodation of Needs

I am committed to the principle of universal learning. This means that our classroom, our virtual spaces, our practices, and our interactions be as inclusive as possible. Mutual respect, civility, and the ability to listen and observe others carefully are crucial to universal learning.

If you are a student who will need accommodations in this class, please contact me to discuss your individual needs. Any accommodation must be discussed in a timely manner. A verifying memo from **The Student Disability Center**  (<https://disabilitycenter.colostate.edu/>) may be required before any accommodation is provided.


The Student Disability Center (SDC) has the authority to verify and confirm the eligibility of students with disabilities for the majority of accommodations. While some accommodations may be provided by other departments, a student is not automatically eligible for those accommodations unless their disability can be verified and the need for the accommodation confirmed, either through SDC or through acceptable means defined by the particular department. Faculty and staff may consult with the SDC staff whenever there is doubt as to the appropriateness of an accommodative request by a student with a disability.

The goal of SDC is to normalize disability as part of the culture of diversity at Colorado State University. The characteristic of having a disability simply provides the basis of the support that is available to students. The goal is to ensure students with disabilities have the opportunity to be as successful as they have the capability to be.

Support and services are offered to student with functional limitations due to visual, hearing, learning, or mobility disabilities as well as to students who have specific physical or mental health conditions due to epilepsy, diabetes, asthma, AIDS, psychiatric diagnoses, etc. Students who are temporarily disabled are also eligible for support and assistance.

Any student who is enrolled at CSU, and who self-identifies with SDC as having a disability, is eligible for support from SDC. Specific accommodations are determined individually for each student and must be supported by appropriate documentation and/or evaluation of needs consistent with a particular type of disability. SDC reserves the right to ask for any appropriate documentation of disability in order to determine a student's eligibility for accommodations as well as in support for specific accommodative requests. The accommodative process begins once a student meets with an accommodation's specialist in the SDC.

## Undocumented Student Support

Any CSU student who faces challenges or hardships due to their legal status in the United States and believes that it may impact their academic performance in this course is encouraged to visit **Student Support Services for Undocumented, ACA & ASSET**  (<https://undocumented.colostate.edu/>) for resources and support. Additionally, only if you feel comfortable, please notify your professor so they may pass along any additional resources they may possess.

## Food Insecurity

Any CSU student (along with faculty and staff) who is experiencing food insecurity can receive support from the **Rams Against Hunger** [\(https://isc.colostate.edu/slice/slice-engagement/rams-against-hunger/\)](https://isc.colostate.edu/slice/slice-engagement/rams-against-hunger/) program. Services include a food pantry, a meal-swipe program, pocket pantries, and in-person assistance with navigating federal aid eligibility. The RAH page includes numerous resources as well as county, state and federal programs which are described and linked.

## Title IX/Interpersonal Violence

For the full statement regarding role and responsibilities about reporting harassment, sexual harassment, sexual misconduct, domestic violence, dating violence, stalking, and the retaliation policy please go to: **Title IX – Sexual Assault, Sexual Violence, Sexual Harassment** [\(http://oeo.colostate.edu/title-ix-sexual-assault/\)](http://oeo.colostate.edu/title-ix-sexual-assault/).

If you feel that your rights have been compromised at CSU, several resources are available to assist:

- Student Resolution Center, 200 Lory Student Center, 491-7165
- Office of Equal Opportunity, 101 Student Services, 491-5836

A note about interpersonal violence: If you or someone you know has experienced sexual assault, relationship violence and/or stalking, know that you are not alone. As instructors, we are required by law to notify university officials about disclosures related to interpersonal violence. Confidential victim advocates are available 24 hours a day, 365 days a year to provide support related to the emotional, physical, physiological and legal aftermath of interpersonal violence. Contact the Victim Assistance Team at: 970-492-4242.

## Religious Observances

CSU does not discriminate on the basis of religion. Reasonable accommodation should be made to allow individuals to observe their established religious holidays.

Please see **CSU's Religious Observances Calendar** [\(https://calendar.colostate.edu/observances/\)](https://calendar.colostate.edu/observances/).

Students seeking an exemption from attending class or completing assigned course work for a religious holiday will need to fill out the **Religious Accommodation Request Form** [\(https://studentaffairs.colostate.edu/resources/resources-faculty-staff/administrative-information/religious-holidays/\)](https://studentaffairs.colostate.edu/resources/resources-faculty-staff/administrative-information/religious-holidays/) and turn it in to the Division of Student Affairs, located on the second level of the Administration building.

Once turned in, the Division of Student Affairs will review the request and contact the student accordingly. If approved, the student will receive a memo from the Dean of Students to give to their professor or course instructor.

Students are asked to turn in the request forms as soon as the conflict is noticed. Similarly, unanticipated conflicts requiring a religious observance, such as a death in the family, can also be reviewed.



## CSU Principles of Community

**Inclusion:** We create and nurture inclusive environments and welcome, value and affirm all members of our community, including their various identities, skills, ideas, talents and contributions.


**Integrity:** We are accountable for our actions and will act ethically and honestly in all our interactions.

**Respect:** We honor the inherent dignity of all people within an environment where we are committed to freedom of expression, critical discourse, and the advancement of knowledge.

**Service:** We are responsible, individually and collectively, to give of our time, talents, and resources to promote the well-being of each other and the development of our local, regional, and global communities.

**Social Justice:** We have the right to be treated and the responsibility to treat others with fairness and equity, the duty to challenge prejudice, and to uphold the laws, policies and procedures that promote justice in all respects.

## Diversity and Inclusion

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you. - [Source](#) 

<https://www.brown.edu/heridan/teaching-learning-resources/inclusive-teaching/statements>

## Student Parents/Guardians/Caregivers

I realize that student parents/guardians and caregivers face distinctive challenges in succeeding academically, and I'm committed to supporting those of you who are parents to achieve our course's learning outcomes. If you encounter challenges in meeting course expectations – for example, fulfilling attendance and participation requirements or submitting assignments due to a child or person in your care's illness, essential appointment, school closure, etc. – please contact me as soon as possible (beforehand if feasible or as soon afterward you reasonably can if not). We'll develop a plan for you to make up missed work. If you need to bring your child or person you care for to class, for example because you're nursing or planned childcare became unavailable, I encourage you to do so if it's feasible for you to participate in class and support your child or person in your care.



Finally, know that **pregnant and parenting students are guaranteed equal educational opportunities by Title IX** [↗\(https://www2.ed.gov/about/offices/list/ocr/docs/dcl-know-rights-201306-title-ix.html\)](https://www2.ed.gov/about/offices/list/ocr/docs/dcl-know-rights-201306-title-ix.html); know your rights, the protections provided, and how to advocate for yourself.

## Student Case Management

**Student case management** [↗\(https://studentcasemanagement.colostate.edu/\)](https://studentcasemanagement.colostate.edu/) is available to help students with extenuating life circumstances and connect them with resources. In some cases, after you and I discuss your situation, I may request **verifiable documentation for class absences** [↗\(https://studentcasemanagement.colostate.edu/class-absences/\)](https://studentcasemanagement.colostate.edu/class-absences/) from the SCM office if you request considerations for absences or missed coursework.

## Mental Health and Wellness


### CSU Has Resources to Help

Many of us are struggling. CSU is a community that cares. You are not alone. CSU Health Network Counseling Services has trained professionals who can help. Your student fees provide access to a wide range of support services. Call Counseling Services at (970) 491-6053, and they will work together with you to find out which services are right for you. Visit <https://health.colostate.edu/about-counseling-services> [↗\(https://health.colostate.edu/about-counseling-services\)](https://health.colostate.edu/about-counseling-services) to learn more and <https://health.colostate.edu/mental-health-resources/> [↗\(https://health.colostate.edu/mental-health-resources/\)](https://health.colostate.edu/mental-health-resources/) for additional student mental health and well-being resources. If you are concerned about a friend or peer, use Tell Someone by calling (970) 491-1350 or visiting <https://supportandsafety.colostate.edu/tell-someone/> [↗\(https://supportandsafety.colostate.edu/tell-someone/\)](https://supportandsafety.colostate.edu/tell-someone/) to share your concerns with a professional who can discreetly connect the distressed individual with the proper resources. Rams Take Care of Rams. Reach out and ask for help if you or someone you know is having a difficult time.

CSU is a community that cares. You are not alone. CSU Health Network Counseling Services has trained professionals who can help. Your student fees provide access to a wide range of support services.







Call Counseling Services at (970) 491-6053, and they will work together with you to find out which services are right for you.

Visit <https://health.colostate.edu/about-counseling-services> [↗\(https://health.colostate.edu/about-counseling-services\)](https://health.colostate.edu/about-counseling-services) to learn more and <https://health.colostate.edu/mental-health-resources/> [↗\(https://health.colostate.edu/mental-health-resources/\)](https://health.colostate.edu/mental-health-resources/) for additional student mental health and well-being resources. An extensive set of mental health resources is available to CSU students: <https://health.colostate.edu/mental-health-resources/> [↗\(https://health.colostate.edu/mental-health-resources/\)](https://health.colostate.edu/mental-health-resources/)

If you are concerned about a friend or peer, use **Tell Someone** by calling (970) 491-1350 or visiting <https://supportandsafety.colostate.edu/tell-someone/> 

(<https://supportandsafety.colostate.edu/tell-someone/>) to share your concerns with a professional who can discreetly connect the distressed individual with the proper resources. Rams Take Care of Rams. Reach out and ask for help if you or someone you know is having a difficult time.

## Course Summary:

Date	Details	Due
Wed Feb 7, 2024	 <a href="https://colostate.instructure.com/courses/180445/assignments/2276806">HW01 Deconvolution Project</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2276806">https://colostate.instructure.com/courses/180445/assignments/2276806</a> )	due by 9am
Wed Feb 28, 2024	 <a href="https://colostate.instructure.com/courses/180445/assignments/2276809">HW02 Iterative phase retrieval</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2276809">https://colostate.instructure.com/courses/180445/assignments/2276809</a> )	due by 9am
Wed Mar 27, 2024	 <a href="https://colostate.instructure.com/courses/180445/assignments/2276811">HW03 Transport of Intensity</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2276811">https://colostate.instructure.com/courses/180445/assignments/2276811</a> )	due by 9am
Wed Apr 17, 2024	 <a href="https://colostate.instructure.com/courses/180445/assignments/2276805">HW04 Beam Propagation Method</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2276805">https://colostate.instructure.com/courses/180445/assignments/2276805</a> )	due by 9am
Wed May 8, 2024	 <a href="https://colostate.instructure.com/courses/180445/assignments/2276807">Final Project</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2276807">https://colostate.instructure.com/courses/180445/assignments/2276807</a> )	due by 11:59pm
	 <a href="https://colostate.instructure.com/courses/180445/assignments/2314695">ECE457 Score</a> ( <a href="https://colostate.instructure.com/courses/180445/assignments/2314695">https://colostate.instructure.com/courses/180445/assignments/2314695</a> )	