

## Computational Photography

EEL 4403 Section 0001

**Class Periods:** T | Period 4 (10:40 AM - 11:30 AM)

R | Period 4 - 5 (10:40 AM - 12:35 PM)

**Location:** FLG 0230

**Academic Term:** Fall 2023

### **Instructor:**

Sanjeev J. Koppal

[sjkoppal@ece.ufl.edu](mailto:sjkoppal@ece.ufl.edu)

3523928942

Office Hours: Tuesday, 1130am-1230pm

### **Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

Please contact through the Canvas website

- [Jackson Arnold jarnold2@ufl.edu](mailto:Jackson Arnold jarnold2@ufl.edu)

### **Course Description**

(3 credits) Fundamentals of computational photography, sensing, imaging and illumination.

### **Course Pre-Requisites / Co-Requisites**

EEL 3135 (or equivalent) or consent of instructor

### **Course Objectives**

The student will be able to demonstrate the basics of computational photography, as it relates to applications in computer vision, graphics, and imaging. The student will be able to explain how models of light from radiometry and optics can be used to understand scene information from images, build novel sensors and create new photographs; the intersection between computing and light, a “camera culture” perspective of technology, professionally use sensors and cameras. The student will be able to write code to create new photographs. There will be in-class labs where practical knowledge of computational photography will be experiences.

### **Materials and Supply Fees**

NA

### **Relation to Program Outcomes (ABET):**

The table below is an example. Please consult with your department’s ABET coordinator when filling this out.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
3. An ability to communicate effectively with a range of audiences	Medium
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Low

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Medium
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

### **Required Textbooks and Software**

- Matlab, ideally with image processing / computer vision toolbox
- Access to a computer and a cellphone with a camera

### **Recommended Materials**

- Title: Robot Vision (Recommended, not required)  
Author: B. K. P. Horn  
Publication date and edition: MIT Press 1986  
ISBN number: 0262081598
- Title: Multiple View Geometry in Computer Vision (Recommended, not required)  
Author: Richard Hartley and Andrew Zisserman  
Publication date, edition, and company: Cambridge  
ISBN number: 9780521540513

### **Course Schedule**

Week 1:

- Lec 1: History of cameras, sensors and light
- Lec 2: Camera culture and computational photography
- Lec 3: Pixels, Video and Art

Week 2:

- Lec 4: Reflectance: basic principles
- Lec 5: Image processing

Week 3:

- Lec 6: Reflectance: algorithms and measurements
- Lec 7: Camera calibration
- Lec 8: Image Warping and morphing

Week 4:

- Lec 9: Lighting and shadows
- Lec 10: Programmable imaging
- Lec 11: Human head rendering

Week 5:

- Lec 12: Interreflections
- Lec 13: Structured light
- Lec 14: Image pyramids, retargeting and fusing images

Week 6:

- Lec 15: Reflection and refraction
- Lec 16: Superresolution
- Lec 17: Mosaicing images

Week 7:

- Lec 18: Caustics of cameras and reflections

- Lec 19: Flutter shutter and temporal coding
- Week 8: (Midterm)
  - Lec 20: Light polarization
  - Lec 21: Camera arrays - 1
  - Lec 22: Optical flow and motion
- Week 9:
  - Lec 23: Basic principles of scattering
  - Lec 24: Camera arrays - 2
  - Lec 25: Spatial textures
- Week 10:
  - Lec 26: Advanced scattering in vision and graphics
  - Lec 27: Catadioptric cameras
  - Lec 28: Temporal textures
- Week 11:
  - Lec 29: Modeling fluids
  - Lec 30: Stereo with planar mirrors
  - Lec 31: Create digital mattes
- Week 12:
  - Lec 32: Optical processing with diffraction
  - Lec 33: Deblurring
  - Lec 34: HDR images
- Week 13:
  - Lec 35: Interference and angle sensitive pixels
  - Lec 36: Polarization imaging
  - Lec 37: Geometry from a single image
- Week 14:
  - Lec 38: High-speed flash photography
- Week 15:
  - Lec 39: Photo tourism
  - Lec 40: Image-based rendering
  - Lec 41: Transient imaging
- Week 16:
  - Lec 42: Presentations (Graduate student's report due)
  - Lec 43: Presentations (Graduate student's report due)

**Attendance Policy, Class Expectations, and Make-Up Policy**

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Assignment	Total Points	Percentage of Final Grade
In class projects (~10)	100 each	15%
Participation in class and Assigned paper discussion	100 each	20%
Midterm Exam	100	35%
Final Exam	100	15%
Presentation (Graduate student's report is part of the presentation)	100	15%
		100%

## **Grading Policy**

The following is given as an example only.

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
70.0 - 80.9	B-	2.67
65.0 - 70	C+	2.33
50.0 - 64.9	C	2.00
45.0 - 50	C-	1.67
40.0 - 44.9	D+	1.33
30.0 - 39.9	D	1.00
20.0 - 29.9	D-	0.67
0 - 19.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***Students Requiring Accommodations***

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### ***Course Evaluation***

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### ***In-Class Recording***

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript

of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Commitment to a Safe and Inclusive Learning Environment***

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, [student-support-hr@eng.ufl.edu](mailto:student-support-hr@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

### ***Campus Resources:***

#### *Health and Wellness*

##### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing

staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

**Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

**Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

*Academic Resources*

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Connections Center**, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.