Updated 12:33p EDT 22 August 2021

ECE 638 Principles of Digital Color Imaging Systems
Course Information

Fall 2021

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Note: The first two pages down to the section called "Overview" is content that is required to be included in each course syllabus by Purdue University.

CRN: 15627

Meeting day and times: MWF, 2:30p – 3:20p

Instructional modality: Sync-Online.

Course credit hours: 3

Prerequisites: see below.

Instructor Contact Information: As indicated below, I will be available for consultation during the scheduled lecture periods, the scheduled office hours, and via e-mail (jpallebach@gmail.com) at other times. I also intend to set up a course site within Piazza. In the past, I have found that this tool is very useful to facilitate interaction with the class. All course information will be available at the course website **https://engineering.purdue.edu/~ece638/** as discussed below. I will only use Brightspace to post the course syllabus, as is required by Purdue University.

Course Description: (from the university catalog)

Basic principles of color science: physiology of the human eye, trichromatic and color opponent models for color and uniform color spaces. Color reproduction in electronic imaging systems: color models for input and output devices, color imaging system calibration, color quantization and halftoning, and color printing. Color appearance and computational color: color appearance models, models for color constancy, and physics-based models for color.

Learning Resources, Technology, and Text: See below.

Learning Outcomes: A student who has successfully completed this course should have achieved the following Learning Outcomes.

1. Understand the basic concepts of color science.
2. Understand and be able to implement the stages of the color imaging pipeline for a digital color imaging system.
3. Understand the basics of digital halftoning, and be able implement simple digital halftoning algorithms.
4. Understand how 2D linear systems and Fourier analysis can be applied to the analysis of digital color imaging systems.
5. Be familiar with and know how to use certain key methods from digital image analysis.

Assignments: See below.

Grading Scales: See below.

Attendance Policy: Attendance at lectures or office hours is not required, and will not be a factor in your final grade.

Academic Guidance in the Event that you are Quarantined/Isolated: Due to the remote nature of the course, this should not be an issue for anyone. However, if circumstances arise

during which you have questions or concerns, please contact me via e-mail. I will do my best to accommodate your needs.

Course Schedule: This will be posted at the course website.

Classroom Guidance Regarding Protect Purdue:

You are personally responsible for checking the Protect Purdue website on a regular basis, and adhering to all practices that are listed there, as required to maintain a safe environment for everyone who is part of the Purdue community, or who is visiting the campus. This is consistent with the Purdue pledge.

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights and the Violent Behavior Policy under University Resources in Brightspace.

Nondiscrimination Policy Statement: Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. The rest of Purdue's Nondscrimination Policy Statement can be found at: *Nondiscrimination Policy Statement.*

Accessibility: Purdue University is committed to making learning experiences accessible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Mental Health/Wellness Statement:

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack**.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

TaskHuman resources: TaskHuman offers private, real-time, on-demand, 1-on-1 video calls with wellness coaches covering over 800+ topics such as anxiety, mindfulness, reducing stress, clean eating, time management, in-home workouts, relationship tensions, financial issues, spiritual guidance and many more. You can access these wellness coaches from around the world 24/7. The College of Engineering has an exclusive agreement with TaskHuman, which gives you **FREE and UNLIMITED** access to these resources. Over 3,200 calls have been made by College of Engineering students, staff, and faculty so far with an average satisfaction rating of 4.89/5.

Learn more here: https://engineering.purdue.edu/ECE/TaskHuman.

DOWNLOAD TASKHUMAN:

Scan the QR Code to download the TaskHuman App or download the TaskHuman App directly from the App Store or Google Play Store

Create an account

Go to Setting and tap on "Check for Discounts"

Insert your code: purdue63
Don't see a topic you want or have other questions? Contact Brooke Parks, Senior Lecturer in ECE, at brookeparks@purdue.edu.

Basic Needs Security: Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the Critical Needs Fund.

Emergency Preparation: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis. In addition, please review the Emergency Preparedness Safety Briefing, sign up for Purdue Alerts to your mobile phone, and watch your mobile phone for a Purdue

Alert text message. Finally, by logging into any Purdue computer connected to the network, you may access Desktop Popup Alerts.

Overview

Welcome to ECE 638!! This document contains course information, based on what is known at this point. Due to my unusual family circumstances, this course, including office hours will be entirely remote, offered via Zoom. I am 71 years old, which puts me in a very vulnerable category with regards to the delta variant, even though I have been fully vaccinated. I also have been diagnosed with prostate cancer. What is more, my wife who is 73 years old has a lymphoma. This is a form of cancer. Fortunately, it seems to be in remission, However, the medication that she took to stop it, destroyed part of her immune system. So she cannot produce antibodies. She receives an infusion of antibodies every six weeks. She is fully vaccinated. But we have no idea whether or not her body has mounted an immune response to the COVID-19 virus. It has been established that since the delta variant is so contagious, it is possible for someone who is fully vaccinated, and who is not experiencing any symptoms to infect others. I do not want to infect my wife, or anyone else for that matter. I would also like to do the best to assure my own health.

So the course will be fully remote at least until the situation with COVID-19 stabilizes, we will use my zoom coordinates: **820-715-4809 with password 338138.** I will record the lectures, and post them at the course website. The course meets on MWF at 2:30p. Nominally, the classroom is ME 2004. However, please don't go there, since no one will be in the classroom, except for the first day of class. Please do feel free to e-mail me at jpallebach@gmail.com, if you have any questions. Please note that I am not currently using my Purdue e-mail account, since I have been having some problems with it, which I have not had time to resolve.

What is this course about?

Color digital imaging systems have become endemic in our daily lives. This includes capture devices, such as digital cameras and scanners, as well as output devices, such as displays and printers. This course provides a thorough and systematic treatment of such systems, including the imaging pipeline for data from image capture devices or for data to be output to a display or printer. This information is essential for those individuals who will be involved in the design of such systems. It is also useful for those individuals who will use such systems and the data, e.g. digital color images, that is processed by those systems. This includes applications of color to computer vision, and the solution of computer vision problems using methods from machine learning and deep learning.

To a large extent, the material covered and the manner in which this material is covered reflects the research that my students and I have conducted over the years with digital color imaging systems. In particular, the perspective that is taken is based on what I have found to be useful for understanding this rich and to me, at least, fascinating area. Basic color science comprises the first part of the course. Interestingly, linear algebra is an important tool for this topic. The second part of the course is devoted to spatial analysis and synthesis of digital color imaging systems. This part draws heavily on linear systems theory and Fourier analysis. The final part of the course is devoted to several advanced topics: color management, image quality, some methods from image processing and image analysis, and the use of color in the solution of computer vision problems.

Important prerequisites or corequisites

This is a 600-level course that builds on a number of prerequisites that the typical ECE graduate student, especially one whose primary area is Communications, Networking, Signal, and Image Processing (CNSIP), has seen earlier in either his or her graduate or undergraduate career. If you are a major from outside ECE, you are certainly welcome to take this course; but I want to warn you at the outset that based on your background, it may be challenging for you. The level of

mathematics in this course is not especially high; but a certain facility with these concepts is needed. The course will cover a lot of material during the semester. Graduate students from outside ECE have successfully taken this course in the past. If you have any questions about your qualifications to take this course, please see me outside the class period. The list below indicates the major topical areas of background that the course will draw upon, what they will be used for, and what are the Purdue courses that cover this material.

Topic	**Used for**	**Purdue course(s) or equivalent**
Linear algebra	Color science, spatial lattice theory	MA 511, ECE 602
Linear systems	Spatial imaging systems	ECE 438, ECE 538, ECE 637
Probability, stochastic processes	Modeling of imaging systems	ECE 302, ECE 600
Color science, image processing	All aspects of the course	ECE 637

Resources

There is no regular textbook for this course. The course will be taught from a variety of sources, including chapters from some books and some journal articles. I will make all these sources available for download. In addition, the slide-set that I will be using for the lecture will be made available, and you will be able to record the lectures.

In addition to the above resources, there are a few books that that may be of interest. I will mention these resources at appropriate times during the semester.

Course Content

As mentioned above, there are three major modules of material for the course, which are listed below:

1. **Basics of color science**
2. **Spatial analysis and synthesis of digital color imaging systems**
3. **Color management, image quality, some methods from image processing and image analysis, and use of color in the solution of computer vision problems**

Important Coordinates

Course web-site **https://engineering.purdue.edu/~ece638/**

Zoom for lecture presentation (https://zoom.us; click "Join a Meeting" on menu bar at upper right; Zoom ID = 820-715-4809. (This information is subject to change.)

Computation of Final Grade (This information is subject to change.)

Course evaluation	2%
Six homework assignments (8.33% each)	50%
Two 2-hour exams (24% each)	48%
Total	100%

Weekly Schedule

Lecture (MWF) remote	2:30p – 3:20p
Office Hours	(to be arranged)

Communicating with Me

Aside from direct contact during lecture periods and posted office hours, the best way to communicate with me is via e-mail sent to jpallebach@gmail.com.

I receive a lot of e-mail. After it rolls above the top of my In-Box, I may forget about it. So please, if you do not receive reply within a reasonable interval, where *reasonable* is a function of the urgency of your request, please send a follow-up. You do not need to be concerned about sending me too much e-mail.

Academic Honesty[1]

The members of the ECE faculty expect every member of the Purdue community to practice honorable and eithical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on homework, quizzes, or examinations will be considered cheating and will not be tolerated. Examples of cheating include (but are not limited to):

- Sharing results or other information during an examination.
- Bringing forbidden material or devices to an examination.
- Working on an exam before or after the official time allowed.
- Requesting a regrade of answers or work that has been altered.
- Submitting homework that is not your own work or engaging in forbidden homework collaborations.
- Representing as your own work anything that is the result of the work of someone else.

At my discretion, cheating on an assignment or examination will result in a reduced score, a zero score, or a failing grade for the course. All occurrences of academic dishonesty will be reported to the Assistant Dean of Students and copied to the ECE Assistant Head for Education. If there is any question as to whether a given action might be construed as cheating, please me before you engage in any such action.

Acceptable and non-acceptable forms of collaboration

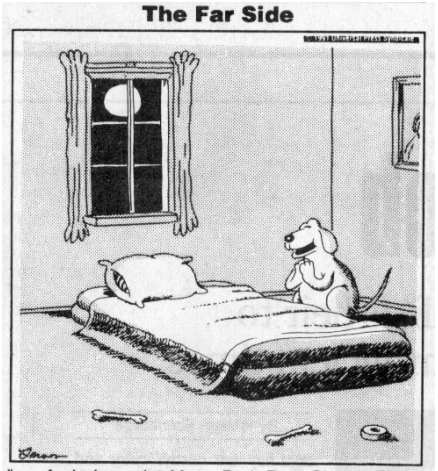
Acceptable:
You are expected collaborate with your classmates during "brainstorming" sessions. You may discuss your approaches to solving your homework problems with others. But what you write down in your solution, including any code that you write should be your own work, and not borrowed for paraphrased from anyone else.

Not acceptable:
During examinations, your answers should be entirely your own. You should not look at what other students may be writing. You should never look at anyone else's work, or use any forbidden sources.

Campus closing/disruption of classes

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In such an event, information will be provided via e-mail at the course website. It may also be prudent to sign up for text-notification from Purdue regarding emergency information.

[1] Policy statement is due to Professor Edwin Chong (now at Colorado State University).


The Far Side
". . . And please let Mom, Dad, Rex, Ginger, Tucker, me and all the rest of the family see color."