**Description:** We focus on the theory and practice behind the generation and manipulation of digital images within a computer graphics context. Topics include image representation and storage, sampling and reconstruction, color systems, affine and general warps, enhancement and morphology, compositing, morphing, non-photorealistic transformations, Fourier space representation and processing. Digital images have the advantages, over any other form of image, of lossless storage, transmission, and retrieval. Their form enables generation, manipulation, and display within a computing environment, and they provide a natural syntax for image representation that pervades the world of computer graphics and visualization. An understanding of their nature and technology is essential to anyone who will be making use of digital images in their academic or professional career.

**Outcomes:** This course will provide a thorough grounding in the state of the art in the treatment of digital images, particularly within the context of computer graphics, and digital effects. It is designed to prepare students to:

- understand existing systems for storage, display, transformation and manipulation of digital images;
- write their own software for working with digital images; and
- undertake creative work and research involving digital images.

Students participate in lectures, read and discuss hand-out material, and complete a series of exercises on the computer that involve programming and making use of graphics libraries.

**Topical Outline** Specific topics are flexible depending on the needs of the students as the course progresses. The planned set of topics includes:

- analog and digital images
- C++ representation, display, & storage of images
- pixmaps
- greyscale and RGB color
- color systems and color spaces
- perception of color
- ACES and OpenColorIO
- color displays and output devices
- LUTS (http://www.redsharknews.com/post/item/2966-the-beginners-guide-to-luts)
- image file formats and libraries
- conversion between formats
- OpenEXR and OpenImageIO
- pixel manipulations
- HDR and tone maps
- image geometry
- fractals
- warping
• lens distortion
• convolution filtering
• image frequency content and analysis
• Fourier space filtering
• temporal and Fourier processing of image sequences
• likelihood theory, matched filtering, target detection, segmentation, & estimation
• multichannel matched filters & target estimates
• image segmentation & rotoscoping
• generalization of channels, deep images
• multichannel representation of AOVs
• concepts of alpha, opacity, and variations
• compositing

Prerequisites: CPSC 212 and MTHSC 311, or DPA 401, or permission of instructor.

Assignments: Most homework assignments involve programming in C++ and may require the use of the open source libraries OpenImageIO, OpenGL, GLUT, and others. Work may be done on any computer supporting C++ and the necessary libraries. However, before turning in an assignment, the program must be compiled and tested under the School of Computing’s Ubuntu Linux environment, and both a working compile script (Makefile, CMakeLists.txt, etc.) and README must be provided. It is acceptable for students to access a suitable School of Computing Linux computer via a browser directed to https://virtual.computing.clemson.edu. In order to turn in programming assignments, all students will need to use their computer science account and the handin system: [https://handin.cs.clemson.edu](https://handin.cs.clemson.edu). All students enrolled in CS courses should automatically be assigned CS accounts. You will need to login early in the semester to change your password, or the account may be expired. If you have problems logging in, send an email to ithelp@clemson.edu from your Clemson email account, or stop by on the first floor McAdams with a picture ID. More information here: [http://www.computing.clemson.edu/help/](http://www.computing.clemson.edu/help/). Each assignment has a due date, but no points are deducted for turning in an assignment after the due date. Assignment grades will be posted in CANVAS. Students in CPSC 6040 will have more in-depth assignments than students in CPSC 4040.

Grading: The grade is a combination of class participation and project assignments. There are no written exams. There are 5 projects in this class. Each is worth 15 points. There are also 25 points possible for class participation (which means you really should participate actively in class, and attend class, whether in-person or online). There is a total of 100 possible points. The grade is relative to the percentage of 100 points achieved. Grades will be posted in CANVAS. Each assignment has a due date that is strongly enforced.

Required Text: None. We will use online materials.

Additional Reading: Many more documents & resources recommended in class and on the webpage.

Communications: Communications between the students and instructor/TA will be via the following mechanisms:

1. Zoom: this will be the video conference platform for office hours. Although office hours will be in-person, students will have the option of attending office hours via Zoom. Just prior to the start of the office hours, a zoom invitation will be generated and posted on Canvas.
2. Canvas: Announcements for the class will be posted to canvas. Canvas will also be the location where assignment grades are posted. Canvas will be the host location for any relevant videos.
3. Email: This mechanism is available as a means of having one-on-one conversations if needed. In unforeseen circumstances, announcements to the class may be posted via email.
4. Office visit: In addition to regular office hours, we can schedule an in-person office visit. Office visits, including office hours, can be attended via Zoom video conference.
5. Webpage: Much of the information for this course is hosted on a webpage for the course.

POLICIES
Late Instructor Policy If the instructor or a lab instructor is late to class or labs, then students should wait at least 15 minutes and check the course announcements before leaving.
Academic Integrity  As members of the Clemson University community, we have inherited Thomas Green Clemson’s vision of this institution as a “high seminary of learning.” Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.

All infractions of academic dishonesty by undergraduates must be reported to Undergraduate Studies for resolution through that office. In cases of plagiarism instructors may use the Plagiarism Resolution Form.

Additionally, for undergraduate classes:

Plagiarism, which includes the intentional or unintentional copying of language, structure, or ideas of another and attributing the work to one’s own efforts. Graded works generated by artificial intelligence or ghostwritten (either paid or free) are expressly forbidden.

See the Undergraduate Academic Integrity Policy website for additional information and the current catalogue for the policy.

For graduate students, see the current Graduate School Handbook for all policies and procedures.

Accessibility  Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the instructor know and are encouraged to request accommodations through SAS (Student Accessibility Services) as soon as possible. To request accommodations through SAS, please see this link: (https://www.clemson.edu/academics/studentaccess/register.html). You can also reach out to SAS with questions by calling 864-656-6848, visiting SAS at the ASC Suite 239, or stopping by the office as a drop-in appointment.

The Clemson University Title IX Statement Regarding Non-Discrimination  Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran’s status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This Title IX policy is located on the Access and Equity website. Ms. Alesia Smith is the Clemson University Title IX Coordinator, and the Assistant Vice President of Equity Compliance. Her office is located at 223 Brackett Hall, 864-656-3181 and her email address is alesias@clemson.edu. Remember, email is not a fully secured method of communication and should not be used to discuss Title IX issues.

Clemson University aspires to create a diverse community that welcomes people of different races, cultures, ages, genders, sexual orientation, religions, socioeconomic levels, political perspectives, abilities, opinions, values and experiences.

Emergency Preparation  Emergency procedures have been posted in all buildings and on all elevators. Students should be reminded to review these procedures for their own safety. All students and employees should be familiar with guidelines from Clemson University Public Safety. Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

1. Familiarize yourself with all possible exits, safer locations, and other key information on the emergency evacuation maps in this building, and those that you visit regularly.

2. Make a plan for how you would Run, Hide, and Fight in case of an active threat in this building, and those that you visit regularly. For example:
   a) Run – what are all the possible exits in this building, and the routes to them?
   b) Hide – what are the potential hiding locations in this room and building that are out of sight of doors and windows, how do you lock the door(s), how would you barricade the door(s) and windows, where do you turn off the lights?
   c) Fight – What tools are available in this room and building, should you have to fight?

3. Ensure you are signed up for emergency alerts. Alerts are only sent when there is a potential threat to safety, a major disruption to campus services, and once-monthly tests.

4. Download the Rave Guardian app to your phone. (https://www.clemson.edu/cusafety/cupd/rave-guardian/)

5. Learn what you can do to prepare yourself for the hazards that affect our locations. (http://www.clemson.edu/cusafety/EmergencyManagement/)