Colonnade Program Course Proposal: Explorations Category

This course is a service course for majors in art, photography, film and related areas, and does not count for the physics major.

1. What course does the department plan to offer in Explorations? Which subcategory are you proposing for this course? (Arts and Humanities; Social and Behavioral Sciences; Natural and Physical Sciences)

Physics 103- Light, Color and Vision
Subcategory: Natural and Physical Sciences

2. How will this course meet the specific learning objectives of the appropriate subcategory. Please address **all** of the learning outcomes listed for the appropriate subcategory.

1. Demonstrate an understanding of the methods of science inquiry.

This is addressed in several ways: first, many of the concepts in the course are introduced through guided discovery experiments, where students work through structured activities to discover for themselves the principle ideas, so they are to a significant extent experiencing and engaging in scientific inquiry themselves. This cumulates in a project in which students working in groups investigate and describe the functioning of an optical instrument. Students also read and write about the history of development of scientific understanding about light, color and vision, learning about important developments and how they came about.

2. Explain basic concepts and principles in one or more of the sciences.

The basic concepts of reflection, refraction, image formation in mirrors and lenses, color and spectra are introduced through class activities which include students using words and drawings to explain to each other the basic concepts, followed up by assignments where students use drawings and words to explain the phenomena in real-world applications on the project and tests.

3. Apply scientific principles to interpret and make predictions in one or more of the sciences.

The above mentioned assignments involve students interpreting the appearance of things like image and shadows, to explain/predict the sizes and locations of images formed by optical elements, and they will be able to predict the resulting color from combining different colors of light and filters.

4. Explain how scientific principles relate to issues of personal and/or public importance

- During the course of the semester, students study how an optical instrument (e.g. cameras, telescopes) works based on fundamental principles. The cumulating is a final project in which groups explain how different optical elements in their chosen instrument combine for it to serve its purpose.

- Regular connections are made between historical progress in science and technology relating to light and color, and historical developments in art and photography, which are personal/professional interests of many students that take the course.
- Reading selections of historical scientific works, class discussions, and essays will seek to help students develop a better understanding of what does and does not constitute valid scientific arguments, which could be applied to better understand technological social issues like energy and global warming.

3. Syllabus statement of learning outcomes for course. NOTE: In multi-section courses, the same statement of learning outcomes must appear on every section's syllabus.

As a result of working through this course, you will be able to:

- Explain how mirrors, lenses, apertures and other optical elements affect the path of light and use ray diagrams to show how light travels through different optical instruments.
- Read and interpret spectral diagrams (a.k.a. light response curves) and use them to explain color mixing by addition and subtraction in different applications.
- Identify various depth perception clues, explain why the function, and use them in constructing images with perception of depth.
- Explain the nature of science and scientific knowledge, including the role of evidence and theory, how it is developed and modified, and interaction of science with technology and society.

4. Brief description of how the department will assess the course for these learning objectives.

1. Demonstrate an understanding of the methods of science inquiry.

- Class participation in hands-on, inquiry learning.
- Written work (essays) about historical inquiry into the nature of light and color.
- Project where students develop their own understanding of how an optical instrument works.

2. Explain basic concepts and principles in one or more of the sciences.

- Use basic concepts and principles to describe how mirrors, lenses and apertures are used to form images as part of the optical instrument project. They will also describe how filters are used to modify color.
- Written work (essays) describing the historical development of the main concepts and principles of light and color.
- Questions on tests where students are used to describe/apply the principles and concepts.

3. Apply scientific principles to interpret and make predictions in one or more of the sciences.

- Students will apply principles in the optical instrument project to predict/explain the location and size of images as a function of distance and other factors.
- Students will have to similarly apply principles in answering drawing/calculating questions on tests about image and/or color formation.

4. Explain how scientific principles relate to issues of personal and/or public importance

- The optical instrument project will involve common instruments such as cameras, binoculars, projectors, telescopes, microscopes, etc. For some students (photojournalism, film and broadcasting) these represent simple versions of tools they use professionally which utilize the same basic physics concepts.
- One aspect of the written essays will be to help students develop a better understanding of the nature of scientific knowledge and how it is communicated, so that they will have more basis for distinguishing scientific and non-scientific claims about science-related issues, such as global warming or energy needs.

5. How many sections of this course will your department offer each semester?

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6. Please attach sample syllabus for the course.

Attached is a syllabus from the past semester. This is a course that has evolved over many semesters, and will continue to evolve as the instructors identify better ways to address the learning objectives.

Physics 103: Light, Color and Vision, Fall 2013

Time & location: TTh 11:10-12:30, TCCW 251
Required workbook: *Light, Color and Vision Workbook,* by Scott Bonham (Spring 2013 edition)
Optional Text: *Seeing the Light* by Falk, Brill and Stork
Additional readings on the web
Office Hours: Monday 2-3, Tuesday 1:30-2:30

Instructor: Dr. Scott Bonham
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Phone: 745-6196

This course is an introductory physics course meeting the general education requirement for a science course with a lab. This course focus on physics and some biology related to Light, Color and Vision. This will be a highly interactive course where you will be regularly working with classmates and constructing your own understanding of the science.

Colonnade Learning Outcomes for Light, Color and Vision

As a result of working through this course, you will be able to:

1. Explain how mirrors, lenses, apertures and other optical elements affect the path of light and use ray diagrams to show how light travels through different optical instruments.
2. Read and interpret spectral diagrams (a.k.a. light response curves) and use them to explain color mixing by addition and subtraction in different applications.
3. Identify various depth perception clues, explain why the function, and use them in constructing images with perception of depth.
4. Explain the nature of science and scientific knowledge, including the role of evidence and theory, how it is developed and modified, and interaction of science with technology and society.

1 Some common vector drawing software packages are Adobe Illustrator, CorelDraw, Macromedia Freehand, AutoCAD and OpenOffice Draw. The last is a free, open-source package that is in the classroom and available at http://www.openoffice.org/.
2 There are many such packages, including Adobe Photoshop (available in campus student labs) and GIMP, and open source package that will be used in the classroom and is available for a free download from http://www.gimp.org/downloads/.

Philosophy of the course

This course is designed based on research on what makes effective science learning. This may be different from previous science classes. Important aspects for learning science include:

- **Take an active role in learning**: We learn by actively taking in information, making sense of it, and applying it. You will do experiments, reason about your observations, consider other's perspective, and apply your understanding. Scientific knowledge is developed through activities like we will do in class. You need to come to class prepared to actively participate and do assignments.

- **Make connections**: One of the biggest differences between experts and novices in a subject is not how much information they have, but rather the experts connect different pieces of information to each other, to other areas, and so are able to find the relevant information when needing it and apply it in different areas.
- **Focus on learning, not "getting the answers right**:" In ten years, what will really matter is your ability to think critically about things, learn on your own, and apply your understanding to different contexts, and not what grade you got on one of my tests. Do not be afraid to ask questions; the person who knows what they don't understand is much closer to true learning than the one who acts like they understand everything.
- **Take responsibility for your own learning:** One of the most important characteristics of a person who is successful learning and in other areas is the ability figure out themselves what needs to be done and to follow through. You should constantly assess what you do and don't understand, and ask questions as needed.

Elements of the course

Class: Almost every day there will be classroom activities and class discussion of materials. You will work with partner(s) to explore different aspects of the topic, along with listening to short presentations of material. Many activities are in your workbook, so bring it to class regularly. The focus will be on developing solid understanding of important topics and the ability to apply them to real-life situations, and not learning a lot of information at a superficial level. **I do not formally keep attendance, however students who frequently miss class do poorly.**

Pre-class questions: Each day there will be a few open-ended questions to answer on the web before you come to class, due at 8 am. These will be graded on a basis of effort, not correctness, and often will not have a single correct answer. These will often be related to the upcoming class, and I will look at the class's responses and use them in the class. Doing this before class is very important to being prepared, so you must do this before you come to class.

Readings: There will be a reading guide for each unit, which can be found in the workbook as well as on Blackboard. These contain readings from the text and from different resources on the web. You do not need to read from them all; many have duplicate information. Rather, you may choose among them and read enough so that you cover all the topics. In addition to being checked, **you will be allowed to use your reading guides on quizzes and exams** (but no other resources).

Homework: There are two types of homework for this class which will help you develop the skills you need for this class. Homework is a critical part of how the course is structure, so YOU WILL NOT DO WELL IN THE COURSE IF YOU DO NOT KEEP UP WITH THE HOMEWORK.

> **Exercises** are for you to work on your own to practice skills from this class. They will not be collected and answers are in the back of the chapter, but you should always make your best effort to solve them without referring to the answers, and ask for help if you cannot figure them out on your own. These are important to practice the basic skills that you will need to be successful in the more complex assignments and for the tests.
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> **Assignments** will be the "capstone" of each unit. In most cases this will involve explaining the phenomena in your photographs using drawing and words. While it is fine help each other out, each person should turn in their own assignment with their own images.

Historical Reading Essays: Three historical reading assignments will be done over the course of the semester. These will consist of reading essays/letters by some of the most important people in the history of understanding the natural world: Aristotle, Isaac Newton and James Clerk Maxwell. You will then write a 1-2 page essay discussing both the developing understanding of the nature of color and the scientific enterprise.

Tests: There will be three hour tests throughout the semester on topics discussed in class. These will involve short essays, drawing diagrams, and simple calculations.

Optical instrument Project. In this project you will explore the workings of an optical instrument, such as a camera, telescope, projector, etc. You will apply what you learn about optical elements like mirrors, lenses and apertures to explain the workings of the instrument, demonstrate your understanding of the physics involved, and explain its importance. Default instruments are either a disposable camera or a reflecting telescope, but you may supply your own (and receive a small amount of additional credit). This must be an instrument you can completely disassemble (re-assembly optional). I expect most people will work in groups of two or three people for this project.

Grading

Your course grade will be based on points you accumulate completing pre-class questions, reading assignments, assignments, quizzes, essays, exams and projects. In part recognition of the diversity of students in this class, I will give you two options for how your grade will be calculated. In particular, grading of the reading assignments, the drawing exercises and the quizzes is designed to provide strong structure and plenty of mile stones to check your understanding and practice critical skills before you get to the exams and projects, during which you will be expected to demonstrate your mastery of the material. (The process of thinking about and responding to pre-class questions and the historical essays is actually viewed as an important part of the learning experience, and so will be treated differently.) You must choose which option you want to use BEFORE each section of the course, and may not change until after the respective exam.

> **Grading option 1: Complete all assignment.** For this option, you will complete all assignments, including reading, drawing and quizzes as well as pre-class questions, essays, exams and projects. This option is strongly recommended for students who don't have a lot of experience in taking college-level courses and/or are not very disciplined students.
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> **Grading option 2: Greater weight for exams**. During each three-unit part of the course, the number of points available on reading assignments, drawing assignments and quizzes will be approximately equal to the exam. Under this option, you will not turn in anything from those categories and your exam score will be weighted about twice to make up the points. This option is designed more for students with a lot of self-discipline who would ensure for themselves they understand the material without having to formally do the assignments and turning them in. You will still need to do the pre-class questions and historical essays, as those assignments are important learning experiences, and the exams and projects.

At the end of this syllabus there is a sheet for you fill out and turn in as to which option you want. After each test, you may change your grading option by submitting a written request.

Grade breakpoints: The total number of points available over the semester will be between 450 and 500. Letter grade break points will be:

A: 400 -up	B: 360-399	C: 310-359	D: 250-309	F: 0-249

This grading scale is roughly based on a maximum of 450 points, so effectively there are "bonus" points built in. There is a "gray area" near the grade breaks, so I reserve the right to adjust grades that are close to a grade break up or down taking into account intangibles such as class participation and effort. The official gradebook will be maintained on Blackboard. You should check your grade regularly to know where you stand. Occasionally, I inadvertently fail to record an assignment. Please keep copies of all your work to show me just in case.

Late policy: I reserve the right to refuse to accept any late assignments or allow quizzes or exams to be made up without a documented, valid excuse. However, in most cases I will allow it with an appropriate late penalty on the score. It is your responsibility to ask.

Anticipated Schedule and Assignments

	Assignment	Due Date*	Points	
			Option 1	Option 2
	Pre-class questions	Each class day	~70 total	~70 total
Part 1: Foundations	Unit 1 Reading Guide	Aug. 29, 2013	4	-
	Scale and perspective drawings	Aug. 29, 2013	8	-
	Shadow drawing	Sept. 3, 2013	12	-
	Unit 2 Reading Guide	Sept. 3, 2013	4	-
	Historical Essay: Sense and the Sensible	Sept. 19, 2013	20	20
	Unit 3 Reading Guide	Sept. 17, 2013	4	-
	Pinhole/perspective drawing	Sept. 19, 2013	12	-
	Mirror Drawing	Sept. 24, 2013	12	-
	Test 1	Oct. 1, 2013	50	106
Part 2: Applications	Unit 4 Reading Guide	Sept. 24, 2013	4	-
	Unit 5 Reading Guide	Oct. 8, 2013	4	-
	Curve Mirror Drawing	Oct. 10, 2013	12	-
	Historical Essay: A New Theory of Colors	Oct. 22, 2013	20	20
	Refraction Drawing	Oct. 17, 2013	12	-
	Unit 6 Reading Guide	Oct. 17, 2013	4	-
	Instrument Scale Diagram	Oct. 24, 2013	5	5
	Lens Drawing	Oct. 29, 2013	12	-
	Test 2	Nov. 5, 2013	50	98
Part 3: Perception	Unit 7 Reading Guide	Nov. 7, 2013	4	-
	Unit 8 Reading Guide	Nov. 14, 2013	4	-
	Combining colors	Nov. 26, 2013	16	-
	Unit 9 Reading Guide	Dec. 3, 2013	4	-
	Historical Essay: On the Theory of Colours	Dec. 5, 2013	20	20
	3-D image	Dec. 5, 2013	12	-
	Test 3	Dec. 9, 2013	50	90
Cul.	Nature of science survey	Nov. 26, 2013	10	10
	Optical Instrument Project final	Dec. 9, 2013	50	50
	Total		**~490**	**~490**

*Dates are tentative and subject to change as need arises.

Disability statement: In compliance with university policy, students with disabilities who require academic and/or auxiliary accommodations for this course must contact the Office for Student Disability Services in Downing University Center, A-200. The phone number is 270-745-5004. Please DO NOT request accommodations directly from the professor or instructor without a letter of accommodation from the Office for Student Disability Services.