SENATE COMMITTEE ON CURRICULAR AFFAIRS

COURSE SUBMISSION AND CONSULTATION FORM

Principal Faculty Member(s) Proposing Course

Name	User ID	College	Department
HEIDI REUTER	her12	Berks College (BK)	Not Available
AZAR ESLAM PANAH	aue10	Berks College (BK)	Not Available

Academic Home: Berks College (BK)

Type of Proposal: ☒ Add ☐ Change ☐ Drop

Course Designation

(PHOTO 321N) Flow Visualization: The Art and Physics of Fluid Motion

Course Information

Cross-Listed Courses:

Prerequisites:

Corequisites:

Concurrents:

Recommended Preparations:

Abbreviated Title:	Flow Vis
Discipline:	General Education
Course Listing:	Inter-Domain

Special categories for Undergraduate (001-499) courses

Foundations

☐ **Writing/Speaking (GWS)**

☐ **Quantification (GQ)**

Knowledge Domains

☐ **Health & Wellness (GHW)**

☒ **Natural Sciences (GN)**

☒ **Arts (GA)**

☐ **Humanities (GH)**

☐ **Social and Behavioral Sciences (GS)**

Additional Designations

☐ **Bachelor of Arts**

☐ **International Cultures (IL)**

☐ **United States Cultures (US)**

☐ **Honors Course**

☐ **Common course number - x94, x95, x96, x97, x99**

☐ **Writing Across the Curriculum**

First-Year Engagement Program

☐ **First-Year Seminar**

Miscellaneous

☐ **Common Course**

GE Learning Objectives

☒ **GenEd Learning Objective: Effective Communication**

☒ **GenEd Learning Objective: Creative Thinking**

☐ **GenEd Learning Objective: Crit & Analytical Think**

☐ **GenEd Learning Objective: Global Learning**

☒ **GenEd Learning Objective: Integrative Thinking**

☐ **GenEd Learning Objective: Key Literacies**

☐ **GenEd Learning Objective: Soc Resp & Ethic Reason**

Bulletin Listing

Minimum Credits:	3
Maximum Credits:	3
Repeatable:	YES
Maximum Total Credits:	3
Department with Curricular Responsibility:	Berks Administration (BKBK_BKADM)
Effective Semester:	FA 2018
Travel Component:	NO

Course Outline

A brief outline or overview of the course content:
This new experimental course on flow visualization can bring together a study of physics and art for all undergraduate students. Both science and art can be described as being fundamentally based in our perception of the world around us. In science, particularly physics, clear observations lead to new discoveries. In art, creating and influencing our own and others' perception of the work is the whole point. The growing disconnect between science and art has been a topic for recent discussion and concern. Flow visualization is particularly suited to fulfill this gap where we will focus on making the physics of fluid flow more visible and artistic.

A listing of the major topics to be covered with an approximate length of time allotted for their discussion:
(Week 1): Introduction to Flow Visualization and Syllabus
(Week 2): Introduction to Cameras and Photography
(Week 3): Introduction to Fluids and Properties
(Week 4): Surface Waves, Surface Tension
(Week 5): Photoshop: Levels, Contrast, Saturation, Crop
(Week 6): Flow Visualization Techniques I in classroom
(Week 7): Clouds and Photography
(Week 8): External Flow and Flow Visualization Techniques II (Smoke, particles)
(Week 9): Florescent dye in darkness Photography
(Week 10): Vortex Flow
(Week 11): Index of Refraction, Drops and Bubbles
(Week 12): Heat Convection
(Week 13): Crown Challenge Presentation in Class Crown Challenge
(Week 14): Final Project Work Period
(Week 15): Final Project Presentation in Class and in Gaige Building Lobby

The list of all topics is included in the attached syllabus with time schedule.

Course Description:
In this course, student will explore techniques for the visualization of the physics of fluid flows including seeding with dyes and particles. Students will also gain technical expertise in a range of flow visualization and photographic techniques drawn from the course topics, such as photographing atmospheric clouds. Assignments are student-driven, to individuals and mixed teams of undergrad students from different majors. This course will reveal the techniques of making laboratory and everyday fluid flows visible for both scientific and aesthetic purposes. Students will create images using photographic techniques, and document their work in written reports. Questions such as "what makes an image scientific?" and "what makes an image art?" will be explored.

The name(s) of the faculty member(s) responsible for the development of the course:

- Name: HEIDI REUTER (her12)
  Title:
  Phone:
  Address:
  Campus: BK
  City:

Fax:

- Name: AZAR ESLAM PANAH (aue10)

Title:

Phone:

Address:

Campus: BK

City:

Fax:

CIP Code: 240102

Course Justification

Instructional, Educational, and Course Objectives:
This section should define what the student is expected to learn and what skills the student will develop.
Objective 1: Students will gain the ability to exchange new ideas in visual form to show the beauty of fluid flow.
Objective 2: Students will achieve the ability to synthesize knowledge across science and art domains, so they will be able to transfer knowledge within and beyond their current contexts by combining analytical and creative skills to cultivate the relationship between science and art.
Objective 3: Student will learn how to think creatively by recognition of the beauty of fluid physics that surrounds us each day. Fluid physics are responsible for a wide range of natural beauties and disasters such as floods, tornadoes, and wildfires. Videos of such disasters are very popular which could be another relationship between art and science that students can learn from this course.

Evaluation Methods:
Include a statement that explains how the achievement of the educational objective identified above will be assessed. The procedures for determining students' grades should be specifically identified.
Students will be evaluated for integrative thinking and domain (GN and GA) objectives in four categories for each assignment: art, science, photographic technique, and documentation. The first category will be graded for whether the intent of the image is realized and whether the image was effective. Science will be evaluated based on how clearly a flow phenomenon is illustrated. The criteria for good photographic techniques are proper exposure, focus, resolution, and presentation. The accompanying report is to describe the intent, the phenomenon, and the photographic technique and will be evaluated for content and clarity. However, expectations for student performance will vary based on their disciplines.
All students are expected to provide written reports and self-assessments with their images, for both science and art perspectives. The required image and report formats are attached to this proposal and will be posted on Canvas and the Flow Visualization website.
Students' grade for this course will be largely determined by the quality of their photography assignments, science reading assignments, reports, quizzes, projects, and participation in critiques using the rubrics. There will be 10 weekly assignments and 2 course projects as well as few quizzes and in-class activities. The instructors believe that the amount of assignments including the photography, editing, science reading assignments, and the accompanying scientific report is sufficient for this GenEd course. All the assignments will be graded for both art and science requirements. The instructors would like to encourage students to take such multi-disciplinary course and distribute the words among their peers and they are afraid more assignments will discourage students. Qualitative feedback will be provided publicly during class critique sessions, by their peers and the instructor. Their reports will be constructively critiqued by instructors. In addition, their work will be publicly archived on the high-visibility Flow Visualization website.

Relationship/Linkage of Course to Other Courses:
This statement should relate the course to existing or proposed new courses. It should provide a rationale for the level of instruction, for any prerequisites that may be specified, or for the course's role as a prerequisite for other courses.
There is no pre-req for this course. This course is similar to PHOTO 100, focused on fluid related objects. Student will learn about the science behind natural phenomena related to fluid flows and learn how to visualize fluid motion. This course needs little Mathematics and Physics background and all the topics will be explained during lecture classes understandable for students of all majors with High School knowledge level.

Relationship of Course to Major, Option, Minor, or General Education:
This statement should explain how the course will contribute to the major, option, or minor and indicate how it may function as a service course for other departments.
This course is part of the new integrative studies for General Education.

A description of any special facilities:
We will use the Fluid Discovery Lab at Penn State Berks, a computer lab classroom, in addition to DSLR cameras and tripods.

Frequency of Offering and Enrollment:
Every Fall semester with an enrollment of 24 students. If we receive requests, we are willing to offer the course ore often.

Alignment with General Education Objectives

☒ **EFFECTIVE COMMUNICATION – the ability to exchange information and ideas in oral, written, and visual form in ways that allow for informed and persuasive discourse that builds trust and respect among those engaged in that**

exchange, and helps create environments where creative ideas and problem-solving flourish.

☐ **KEY LITERACIES – the ability to identify, interpret, create, communicate and compute using materials in a variety of media and contexts. Literacy acquired in multiple areas, such as textual, quantitative, information/technology, health, intercultural, historical, aesthetic, linguistic (world languages), and scientific, enables individuals to achieve their goals, to develop their knowledge and potential, to lead healthy and productive lives, and to participate fully in their community and wider society.**

☐ **CRITICAL AND ANALYTICAL THINKING – the habit of mind characterized by comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating a conclusion. It is the intellectually disciplined process of conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.**

☒ **INTEGRATIVE THINKING – the ability to synthesize knowledge across multiple domains, modes of inquiry, historical periods, and perspectives, as well as the ability to identify linkages between existing knowledge and new information. Individuals who engage in integrative thinking are able to transfer knowledge within and beyond their current contexts.**

☒ **CREATIVE THINKING – the capacity to synthesize existing ideas, images, or expertise in original ways and the experience of performing, making, thinking, or acting in an imaginative way that may be characterized by innovation, divergent thinking, and intellectual risk taking.**

☐ **GLOBAL LEARNING – the intellectually disciplined abilities to analyze similarities and differences among cultures; evaluate natural, physical, social, cultural, historical, and economic legacies and hierarchies; and engage as community members and leaders who will continue to deal with the intricacies of an ever-changing world. Individuals should acquire the ability to analyze power; identify and critique interdependent global, regional, and local cultures and systems; and evaluate the implications for people's lives.**

☐ **SOCIAL RESPONSIBILITY AND ETHICAL REASONING – the ability to assess one's own values within the social context of problems, recognize ethical issues in a variety of settings, describe how different perspectives might be applied to ethical dilemmas, and consider the ramifications of alternative actions. Individuals should acquire the self-- knowledge and leadership skills needed to play a role in creating and maintaining healthy, civil, safe, and thriving communities.**

What component(s) of the course will help students acheive the General Education Learning Objectives covered in the course? Provide evidence that students in the course have adequate opportunities to achieve the identified learning objectives.

• EFFECTIVE COMMUNICATION – One important objective of this course is to expose students to simple physics of fluids which cannot be accomplished verbally, but only visually. Students will gain the ability to exchange new ideas in visual form to show the beauty of fluid flow.
• INTEGRATIVE THINKING – Another important objective of this course is to help students to look at things from a different perspective and become more open to an aesthetic appreciation of, and motivation for, other fields of science and engineering which may lead to life-long learning even if they don't continue in their study of fluids or photography. They will achieve the ability to synthesize knowledge across engineering and art domains, so students will be able to transfer knowledge within and beyond their current contexts by combining analytical and creative skills to cultivate the relationship between science and art.
• CREATIVE THINKING – This course has the capacity to promote creative thinking by recognition of the beauty of fluid physics that surrounds us each day. Fluid physics are responsible for a wide range of natural beauties and disasters such as floods, tornadoes, and wildfires. Videos of such disasters are very popular which could be another relationship between art and science that we can learn from this course. Many fluid physicists are motivated not only by the important scientific goals of their work, but also by a fascination with their subject.

How will students be assessed to determine their attainment of the Learning Objective(s) of General Education covered in this course? This assessment must be included as a portion of the student's overall performance in this course.

The main objectives of this course are:
• EFFECTIVE COMMUNICATION – Reports will be required for each image and student work will be evaluated for both artistic and scientific merit. Students will be challenged to find the beauty in the interaction between different fluids and documenting the outcome through photography assignments. Students will be asked to participate in critique sessions during class after each assignment. To assess students' communication skills, qualitative feedback will be provided publicly during class critique sessions by their peers. Then, the instructors discuss selected images as examples of quality in one or more category. Students will also prepare detailed self-evaluation, working from a check-off sheet derived from the rubric. Instructors collect the work and review the self-assessments. As shown in the syllabus, there will be many Discussion sessions of art and physics of images. Moreover, students' work will be presented to the public in a number of ways. Their work will be publicly archived on the high-visibility Flow Visualization website. In addition, at the end of the semester, a public display of the students' work will be held in the lobby of the Gaige building and the Art Gallery. Students will be asked to explain their work to students and faculty from other disciplines, as well as public audiences. Moreover, the best works will be entered to Gallery of Fluid Motion competition which is held in conjunction with the American Physical Society Division of Fluid Dynamics (APS-DFD) annual fall meeting and will be able to network with the scientist in the field. Gallery entries are judged "based upon criteria of scientific merit, originality, and artistry/aesthetic appeal." Winners are published in a peer-reviewed journal, Physics of Fluids. The instructors of this course are the winners of 2017 Gallery of Fluid Motion and will make sure the students have a high-quality presentation.

• INTEGRATIVE THINKING – Students will be asked to work on an assignment for each topic taught in the class. The assignments reflect the science behind a natural phenomena related to fluids and a technique to visualize it. One important objective of this course is to help students to look at things from a different perspective and become more open to an aesthetic appreciation of, and motivation for, other fields of science and photography which may lead to life-long learning even if they don't continue in their study of fluids or photography. They will achieve the ability to synthesize knowledge across science and art domains, so students will be able to transfer knowledge within and beyond their current contexts by combining analytical and creative skills to cultivate the relationship between science and art. Please see the attached "Image Assessment Form" which will be used by students and instructors to evaluate students work for both art and science domains. Students report will also be evaluated by instructors using the attached rubric.

• CREATIVE THINKING – Students will be in groups to image complex flow phenomena and attempt more challenging imaging techniques for their final project. The teams will be chosen to spread out photographic and fluids expertise and equipment among the teams. Students will interact with students from different backgrounds and they should come up with a creative idea for their project. All students are expected to provide written reports and self-assessments with their images. The required image and report formats are attached to this proposal and will be posted on the Canvas page and Flow Visualization website. For the projects, students will be given access to instructional and research flow facilities at Penn State Berks. These include an open channel flow flume and a 150 gallon aquarium tank in our Fluid Discovery Lab. The water channel facility has a controllable dye injection system and students can be creative how to use it for their own projects. Students can also make their own small scale equipment, and independently develop a number of innovative materials and unusual flow phenomena.

General Education Domain Criteria

General Education Designation: Inter-Domain

GA Criteria

☒ **Explain the methods of inquiry in arts fields and describe how the contributions of these fields complement inquiry in other areas**

☐ **Demonstrate an expanded knowledge and comprehension of the role that the arts play in various aspects of human endeavor**

☒ **Demonstrate competence in the creation of works of art and design**

☒ **Demonstrate competence in analysis, critical thinking and interpretive reasoning through the exploration of creative works**

☐ **Identify and explain the aesthetic, historic, social, and cultural significance of important works of art and critically assess creative works, their own or others', through evaluative processes of analysis and interpretation**

What components of the course will help students acheive the domain criteria selected above?

Students will achieve the GA domain criteria through photography techniques, photo assignments, editing images in Photoshop, in class critiques and discussions.

To help students achieve the ability to explain the methods of inquiry in arts fields and describe how the contributions of these fields complement inquiry in other areas, students will be provided with various photography and flow visualization techniques. All students are expected to provide written reports and self-assessments with their images for each assignment. The required image, report format, and rubric will be posted on Canvas.

To help students achieve the ability to demonstrate competence in the creation of works of art and design, students will be provided with fundamental knowledge of various components of image analysis. Students will be in groups to image complex flow phenomena and attempt more challenging imaging techniques for their crown challenge assignment and final project. Students may design their own small scale equipment to achieve their final outcome.

To help students achieve the ability to demonstrate competence in analysis, critical thinking and interpretive reasoning through the exploration of creative works, students will be provided with good examples of flow visualizations images. The instructors will explain the image components and students will be asked to participate in critique sessions during class after each assignment. Qualitative feedback will be provided publicly during class critique sessions, by their peers and the instructors. This helps students to look at things from a different perspective and become more open to an aesthetic appreciation of, and motivation for, other fields.

GN Criteria

☒ **Explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas**

☒ **Construct evidence-based explanations of natural phenomena**

☒ **Demonstrate informed understandings of scientific claims and their applications**

☐ **Evaluate the quality of the data, methods, and inferences used to generate scientific knowledge**

☐ **Identify societal or philosophical implications of discoveries in the natural sciences, as well as their potential to address contemporary problems**

What components of the course will help students acheive the domain criteria selected above?

Through this course, students will look at things from a different perspective and become more open to an aesthetic appreciation of, and motivation for, other fields of science and engineering which may lead to life-long learning even if they don’t continue in their study of fluids or photography.

To help students achieve the ability to explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas, basic fluid-related topics in physics will be taught during lecture classes. Students will be asked to provide written reports with their images on each topic which will be evaluated for scientific merit.

To help students achieve the ability to construct evidence-based explanations of natural phenomena, a wide range of natural beauties and disasters such as floods, tornadoes, and wildfires will be explored during classes. Videos of such disasters are very popular where students can learn science of such natural phenomena from this course. Students will be asked to search the web in order to find such works and explain it in the class for science perspective.

To help students achieve the ability to demonstrate informed understandings of scientific claims and their applications, students will be engaged in course readings, class discussions, and lectures that provide both a fundamental knowledge of the major theories of fluid dynamics, and specific information regarding various flow phenomena. Students will be asked to read some non-technical fluid-related articles and answer multiple choice questions or write an essay regarding the material they have learned through that article.

Integrative Studies

Explain how the intellectual frameworks And methodologies of the two Knowledge Domains will be explicitly addressed in the course and practiced by the students.

This new experimental course on flow visualization will be offered to a mixed class of students with different backgrounds. Course content includes fluid flow physics, history of photography with respect to the relationship of science and art, as well as flow visualization and photography techniques. Issues such as “What makes an image art? What makes an image scientific?” will be addressed. The class focuses on studio/laboratory experiences for mixed teams of students. A range of fluids apparatus will be made available, and students can also create novel flows. Knowledge of flow visualization will be explicitly addressed in the course via weekly lectures, assigned readings, viewing related feature images, and related class discussions. Knowledge of image analysis and its related components (e.g., frame, lighting, etc.) will be explained to highlight the science and photography techniques. Students will be able to practice the application of knowledge from both domains as they engage in weekly class discussions and assignment reports that ask them to integrate and translate this information into recommendations to create accurate, compelling, creative flow visualization images. Reports are required for each image and student works are evaluated for both artistic and scientific merit. This will influence their own attitudes and perceptions of various forms of fluid flow. One outcome of the course is the recognition by students of the beauty of fluid physics that surrounds us each day, leading to motivation for life-long learning. This course represents a radical departure from normal curricula; and hopefully will be very successful in attracting all students, engineering women in particular.

Demonstrate that each Of the two domains will receive approximately equal attention, providing evidence from course topics, assignments, or other course components, and that students will integrate material from both domains.

For each topic, students will participate in a lecture on the physics of fluid flow. Then, a photography technique class following the lecture will be provided. There will be four lectures on basic photographic techniques: optics, exposure, resolution, composition. This will be primarily for the benefit of the students, who have little or no photography experience. Emphasis will be placed on the quantitative aspects of optics and the interrelationship of spatial and temporal resolution in the measurement of fluid flows. The art component consists of lectures on the history of photography, with emphasis on its evolution from science to art. There will be four lectures on flow visualization techniques for gas and liquid flows, including a guest lecture on laser induced fluorescence. Three additional lectures on basics of fluid physics includes a survey of fluid phenomena, the use of non-dimensional parameters, and a guest lecture on the physics of clouds. After the cloud lecture, students will routinely come to class for approximately six lectures on surface Waves, surface tension, external flow over objects, vortex flow , index of refraction, heat convection, Kelvin-Helmholtz shear instabilities, and the bubbles/droplets. Please see the course schedule table in the syllabus.

Briefly explain the staffing plan. Given that each Inter-Domain course is approved for two Knowledge Domains, it will be taught by an instructor (or instructional team) with appropriate expertise in both domains.

This course will be co-taught by a faculty in Art who teaches PHOTO 100 and another faculty in Engineering who teaches ME 320. Both faculty members have taught those courses for many years and they are so excited to teach this course together.

Describe the assessments that will be used to determine students' ability to apply integrative thinking.

Students will be evaluated for integrative thinking and domain (GN and GA) objectives in four categories for each assignment: art, physics, photographic technique, and documentation. The first category will be graded for whether the intent of the image is realized and whether the image was effective. Physics will be evaluated based on how clearly a flow phenomenon is illustrated. The criteria for good photographic techniques are proper exposure, focus, resolution, and presentation. The accompanying report is to describe the intent, the phenomenon, and the photographic technique and will be evaluated for content and clarity. As mentioned in the syllabus, there will be 10 weekly assignments and 2 course projects as well as few quizzes and in-class activities. Students will be given some scientific articles to read after each topic. Then, they will be quizzed on the science part of each topic. Students’ grade will be affected by their performance on these quizzes as well as their HW assignments and projects. Moreover, the accompanying report for each assignment will be graded for the science learning. We will also discuss "what makes an image art?" and "What makes an image science?". The answer to the latter is easy: any image of fluid flow can be considered science if the conditions of the fluid flow and the image acquisition and production process are known. The answer to the former is, of course, a matter of personal interpretation. Despite the light treatment of art in the formal lectures, images produced by the students will be evaluated for artistic and scientific merits in all assignments (HW, projects, etc.).

Campuses That Have Offered ( ) Over The Past 4 Years

semester	AB	AL	BK	BR	BW	CR	DS	ER	FE	GA	GV	HB	HN	HY	LV	MA	NK	PC	SH	SL	UP	WB	WC	WS	XC	XP	XS	YK

UPLOADED DOCUMENTS FOLLOW:

Image Assessment Form
Flow Visualization
Fall 2018

Name(s)

Assignment: Date:

Scale: +, ! = excellent √ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Comments
Intent was realized		
Effective		
Impact		
Interesting		
Beautiful		
Dramatic		
Feel/texture		
No distracting elements		
Framing/cropping enhances image		

Flow	Your assessment	Comments
Clearly illustrates phenomena		
Flow is understandable		
Physics revealed		
Details visible		
Flow is reproducible		
Flow is controlled		
Creative flow or technique		
Publishable quality		

Photographic/video technique	Your assessment	Comments
Exposure: highlights detailed		
Exposure: shadows detailed		
Full contrast range		
Focus		
Depth of field		
Time resolved		
Spatially resolved		
Photoshop/ post-processing enhances intent		
Photoshop/ post-processing does not decrease important information		

Report		Your assessment	Comments
Collaborators acknowledged			
Describes intent	Artistic		
	Scientific		
Describes fluid phenomena			
Estimates appropriate scales	Reynolds number etc.		
Calculation of time resolution etc.	How far did flow move during exposure?		
References:	Web level		
	Refereed journal level		
Clearly written			
Information is organized			
Good spelling and grammar			
Professional language (publishable)			
Provides information needed for reproducing flow	Fluid data, flow rates		
	geometry		
	timing		
Provides information needed for reproducing vis technique	Method		
	dilution		
	injection speed		
	settings		
lighting type	(strobe/tungsten, watts, number)		
	light position, distance		
Provides information for reproducing image	Camera type and model		
	Camera-subject distance		
	Field of view		
	Focal length		
	aperture		
	shutter speed		
	Frame rate, playback rate		
	ISO setting		
	# pixels (width X ht)		
	Photoshop and post-processing techniques		
	"before" Photoshop image		

Report Guidelines

Flow Visualization: The Art and Physics of Fluid Motion

All work must be submitted in Canvas, **and** in your image post on website. The self-assessment document should be submitted as a separate file on Canvas only.

The baseline goal of the report is to provide context for the image, and enough documentation that the image could be re-created. All students will be expected to write the report in a professional fashion. The report is expected to be 1 page in length at a minimum, two pages maximum. Use a descriptive narrative, rather than a list of items.

First Paragraph: Give the context and purpose for the image. For example, second project, group working on flume. Describe the intent of the image, what phenomenon you were trying to see. OK to mention false starts here, but the rest of the report should only deal with the final image. Assume the report will be read by strangers who know nothing of the course. *Be sure to explicitly acknowledge any teammates who helped you get the shot.*

Second Paragraph (or more): Describe flow apparatus used in the image, and refer to a sketch. Describe the basic flow, i.e. flow over a submerged obstacle, flame impinging on an orange, turbulent boundary layer on a wing, etc. Give size or scale of object, width of channel, etc. Then discuss the flow itself.

Expectations for flow discussion vary with student category. All students should think in terms of forces acting on the fluid: why does it look like that? If it is changing with time, why? What forces are making it move? Arts students are expected to describe what they did in enough detail that somebody else could repeat it for a similar result. Engineering students should estimate appropriate non-dimensional scales: Reynolds number, Grashof number, etc., as well as the required time and spatial resolution based on flow speed and field of view. Include the symbolic calculation as well as the numbers and units you used. For example (in water):

$$Re = \frac{UD}{\upsilon} = \frac{\left(0.1\,\frac{m}{s}\right)(0.05\,m)}{1.004\ \times 10^{-6}\,\frac{m^2}{s}} = 5000$$

where the velocity scale was chosen because…. etc. Please use proper significant figures in the result. Be sure to describe what the scale means in this context. For example, "The Reynolds number was 1500, which means the flow was transitional, and might have been laminar or turbulent. Here we can see large vortexes but no smaller scales suggesting the flow is still laminar…."

Engineering students should research the phenomenon at least at the web level and they are expected to discuss additional context for the flow physics and give at least two references to the archival (refereed) technical literature. Finding a fluid property in a textbook is not a sufficient investigation of the physics in the literature.

Any information about the flow that you get from publications or the web needs to be properly cited. See the examples at the end of this document, and Allen (2000).

Third Paragraph: Describe the visualization technique used: Dye, smoke etc. Specify details such as exact source of materials, any relevant environmental conditions. Give dilutions if appropriate. In second part of paragraph, describe the lighting used: flash on camera, bright sunshine, laser emission, etc. Again, the minimum goal is to provide enough information for the image to be repeated.

Fourth Paragraph: Describe the photographic technique, and **why** you made the choices you did.

- Size of the field of view
- Distance from object to lens
- Lens focal length and other lens specs.
- Type of camera: film or digital, including original and final image width and height in pixels, then give make and model.
- Exposure specs: Aperture, shutter speed, and ISO setting
- Photoshop or Final Cut processing. Describe manipulations, settings. If used, provide a “before” image too.

Most digital cameras automatically record the exposure and lens specs in the image file. Info can be viewed in file properties or Photoshop: File menu, File Info, Section:EXIF.

Fifth Paragraph: Describe what the image reveals. What do you like and dislike about the image? How well are fluid physics shown? What questions do you have? Did you fulfill your intent? What aspect would you like to improve? What direction could you go in developing this idea further?

Complete a self assessment of the image and report, and submit it on Canvas with the report, but in a separate file. Assessment forms can be downloaded from the class website.

Example: Cloud Image Reports

First Paragraph: Give the context and purpose for the image. For example, second cloud assignment. Describe the intent of the image, what phenomenon you were trying to see. OK to mention false starts here, but the rest of the report should only deal with the final image. Assume the report will be read by strangers who know nothing of the course.

Second Paragraph: Describe the circumstances of the image:
Location
Direction and elevation (angle from horizontal) camera was facing
Date and time of day

Third Paragraph: Statement of what clouds are in the image, and the data and information supporting your statement. Include the appearance of the rest of the sky, and previous and expected weather. Was there a front approaching? Had the clouds been similar the day before? Did it rain or snow within a few hours of the image? Winds? Discuss the stability of the atmosphere. Include the closest skew-T plot. Discuss what cloud heights could be expected, and whether that agrees with your observation. What types of clouds would be expected from the stability and the general weather. Is that what you observed in your image? Estimate the elevation of the clouds. Describe winds aloft if appropriate. Discuss the physics leading to the imaged clouds.

Be careful to use the right skew-T plot. If you want today's 6 pm sounding, it should have a timestamp of 00Z *with tomorrow's date.* Links to the archives are on the Flow Vis website.

Fourth Paragraph: Describe the photographic technique, and what influenced your choices

- Estimate the size of the field of view
- Distance from object to lens
- Lens focal length and other lens specs.
- Type of camera: film or digital, including original and final image width and height in pixels, then give make and model.
- Exposure specs: Aperture, shutter speed, and ISO setting
- Photoshop or Final Cut processing. Describe manipulations, settings. If used, provide a "before" image too.

Most digital cameras automatically record the exposure and lens specs in the image file. Info can be viewed in Photoshop: File menu, File Info, Section:EXIF.

Fifth Paragraph: Describe what the image reveals. What do you like and dislike about the image? How well are fluid physics are shown? What questions do you have? Did you fulfill your intent? What aspect would you like to improve? What direction could you go in developing this idea further?

Complete a self assessment of the image and report, and attach to the report. Assessment forms can be downloaded from the class website.

Reference and Citation examples

There are two common styles for citations; alphabetical and numbered. Here are examples of each:

Alphabetical

Diethyl phthalate is a good choice for cardiovascular modeling because of its high index of refraction and low viscosity. This is coupled with a health hazard rating of 1, flammability rating of 1 and a reactivity rating of 0 (Fischer 2005). DEP is a commonly used plasticizer, present in many household products, and is not a health hazard according to a current toxicological review (Api 2001). There has been some controversy about its effects on human health (Colon et al. 2000; Hill et al. 2003; Sonde et al. 2000) but this can be mitigated by simple laboratory procedures including handling with gloves and adequate ventilation. It is also relatively inexpensive at approximately $16 per liter (Fischer 2005).

You could also use the citation in a sentence like " Fischer (2005) found that …."

At the end of the report, give the correct reference for each citation. Don't include a reference unless you cited it in the text. Make it as complete as possible, so it's easy for somebody else to look up. List each in alphabetical order, by first author and year:

Fischer Scientific (2005) http://www.fischerscientific.com

Forsythe W (ed) (1954) Smithsonian physical tables, 9th edn. The Smithsonian Institution, Washington

Giner J, Ibarz A, Garza S, Xhian-Quan S (1996) Rheology of clarified cheery juices. J Food Eng 30:147–154

Hill S, Shaw B, Wu A (2003) Plasticizers, antioxidants, and other contaminants found in air delivered by PVC tubing used in respiratory therapy. Biomed Chromatogr 17:250–262

Numbered

Vortex/wall interactions are found in many fluid systems,[1] particularly in aerodynamic applications. For example, a vortex generated on the surface of a maneuvering airfoil during a dynamic stall process can interact with the airfoil surface, affecting the aerodynamic properties.[2–4] Vortex/wall interactions have also been studied as an important element of turbulent boundary layers:[5–7] the legs of a

References

[1]T. L. Doligalski, C. R. Smith, and J. D. A. Walker, ‘‘Vortex interactions with walls,’’ Annu. Rev. Fluid Mech. **26**, 573 (1994).
[2]W. J. McCroskey, ‘‘Unsteady airfoils,’’ Annu. Rev. Fluid Mech. **14**, 285 (1982).
[3]M. S. Francis and J. E. Keesee, ‘‘Airfoil dynamic stall performance with large-amplitude motions,’’ AIAA J. **23**, 1653 (1985).
[4]L. Carr, ‘‘Progress in analysis and prediction of dynamic stall,’’ J. Aircraft **25**, 6 (1988).

You can use superscript numbers as shown, or numbers in brackets [1]. However you do it in the text body, use the same format in the reference list.

There are tools to help with this; the Endnote feature in Word, or the program ‘Endnote’. There are database systems as well. Zotero, which works within Firefox, keeps track of all kinds of references, and inserts them into Word in whatever format you need. Refworks is similar, and works well with the CU Library system.

References

“Citing References in Scientific Research Papers.” Accessed August 3, 2016. http://tim.thorpeallen.net/Courses/Reference/Citations.html.

Expectations For Teams
Flow Visualization
Fall 2018

Reasons for putting you on teams:

1. So that you can attempt to image more complex flow phenomena. If the work of developing a setup is spread out among you, then you can try a challenging experiment.
2. So that you can attempt more challenging imaging techniques. The teams were chosen to spread out photographic and fluids expertise and equipment amongst the teams.
3. To have partners to bounce ideas off of. This makes ideas multiply.
4. To get informal feedback on your work.
5. To interact with students from different backgrounds.

Thus, working on a team is STRONGLY EXPECTED, but not strictly required for the team assignments. You are not required to work only with your team, but you are expected to make significant effort to be available to help them with their images and ideas. You do not all have to use the same equipment. Do plan to spend at least an hour or two to help **each** of your teammates, and recognize that you can plan on having 4 to 8 person-hours at your disposal for your project. Plan multiple meetings. If you find you are not available for specific sessions, figure out how to make it up to your team.

I hope you will take advantage of the benefits of working in teams and of the opportunity to broaden your network. Strong recommendation: don't work only with your friends. Bad for you professionally.

Following from this, here are the expectations for the deliverables on the team assignments:

Each student is expected to turn in a unique image or video that they had primary artistic and scientific responsibility for. You must give credit appropriately in your report, by explicitly naming the teammates that contributed, and what they did.

Each image/video must be accompanied by a report (Look at the report guidelines). If several images come out of the same setup, you can copy descriptions of the apparatus, and the basic physics. If appropriate, give credit to report section authors. Be sure to describe the details relevant to your particular image.

PennState Berks

PHOTO 321N – Flow Visualization

The Art and Physics of Fluid Motion

Class meeting times: Tu/Th, 9:05 am – 10:20 am
Class meeting location: Gaige Building, Room 249
Courses Category: GenEd (GA+GN)
Pre-requisites: **None**
Instructor (Physics of Fluid Motion): Dr. Azar Eslam-Panah
- **E-mail:** aue10@psu.edu
- **Office:** 233 Gaige
- **Office Hours:** Tu/Th, 4:00 pm-5:30pm. Also, available by appointment.

Instructor (Art of Fluid Motion): Heidi Reuter
- **E-mail:** her12@psu.edu
- **Office Hours:** By appointment (best form of contact is email).

COURSE DESCRIPTION

In this course, student will explore techniques for the visualization of the physics of fluid flows including seeding with dyes and particles. Students will also gain technical expertise in a range of flow visualization and photographic techniques drawn from the course topics, such as photographing atmospheric clouds. Assignments are student-driven, to individuals and mixed teams of undergrad students from different majors. This course will reveal the techniques of making laboratory and everyday fluid flows visible for both scientific and aesthetic purposes. Students will create images using photographic techniques, and document their work in written reports. Questions such as "what makes an image scientific?" and "what makes an image art?" will be explored.

COURSE OBJECTIVES AND OUTCOMES

The main objectives of this course are:

- **EFFECTIVE COMMUNICATION** – One important objective of this course is to expose students to simple physics of fluids which cannot be accomplished verbally, but only visually. Students will gain the ability to exchange new ideas in visual form to show the beauty of fluid flow. Reports will be required for each image and student work will be evaluated for both artistic and scientific merit. Students will be challenged to find the beauty in the interaction between different fluids and documenting the outcome through photography.
- **INTEGRATIVE THINKING** – Another important objective of this course is to help students to look at things from a different perspective and become more open to an aesthetic appreciation of, and motivation for, other fields of science and engineering which may lead to life-long learning even if they don't continue in their study of fluids or photography. They will achieve the ability to synthesize knowledge across engineering and art domains, so students will be able to transfer knowledge within and beyond their current contexts by combining analytical and creative skills to cultivate the relationship between science and art.
- **CREATIVE THINKING** – This course has the capacity to promote creative thinking by recognition of the beauty of fluid physics that surrounds us each day. Fluid physics are responsible for a wide range of natural beauties and disasters such as floods, tornadoes, and wildfires. Videos of such disasters are very popular which could be another relationship between art and science that we can learn from this course. Many fluid physicists are motivated not only by the beauty of their work, but also by a fascination with their subject.

COURSE MATERIALS

- Equipment: Camera (Required)
- Textbook: Flow Visualization Techniques and Examples by A. J. Smits and T. T. Lim (Recommended)
- Textbook: An Album of Fluid Motion, Van Dyke ed. Parabolic Press, 1982 (Recommended)

STUDENT EVALUATIONS

Students will be evaluated for integrative thinking and domain (GN and GA) objectives in four categories for each assignment: art, science, photographic technique, and documentation. The first category will be graded for whether the intent of the image is realized and whether the image was effective. Science will be evaluated based on how clearly a flow phenomenon is illustrated. The criteria for good photographic techniques are proper exposure, focus, resolution, and presentation. The accompanying report is to describe the intent, the phenomenon, and the photographic technique and will be evaluated for content and clarity. However, expectations for student performance will vary based on their disciplines.

All students are expected to provide written reports and self-assessments with their images, for both science and art perspectives. The required image and report formats are attached to this proposal and will be posted on Canvas and the Flow Visualization website.

Students' grade for this course will be largely determined by the quality of their photography assignments, science reading assignments, reports, quizzes, projects, and participation in critiques using the rubrics. There will be 10 weekly assignments and 2 course projects as well as few quizzes and in-class activities. The instructors believe that the amount of assignments including the photography, editing, science reading assignments, and the accompanying scientific report is sufficient for this GenEd course. All the assignments will be graded for both art and science requirements. The instructors would like to encourage students to take such multi-disciplinary course and distribute the words among their peers and they are afraid more assignments will discourage students. Qualitative feedback will be provided publicly during class critique sessions, by their peers and the instructor. Their reports will be constructively critiqued by instructors. In addition, their work will be publicly archived on the high-visibility Flow Visualization website.

Proposed Course Topics and Schedule (This schedule is subject to change)

Period	Date	Topic	Assignments
1 (Week 1)		Introduction to Flow Visualization and Syllabus Background Quiz	Favorite Flow image
2		Introduction to Cameras	
3 (Week 2)		**Photography:** Practice Roll - Using the cameras	In Class objects
4		Discussion of art and physics of images	
5 (Week 3)		**Science:** Introduction to Fluids, Properties	Reading
6		**Science:** Surface Waves, Surface Tension	Reading
7 (Week 4)		**Photography:** Shooting together at park	Water Surface
8		Discussion of art and physics of images	
9 (Week 5)		**Photoshop:** Levels, Contrast, Saturation, Crop	
10		**Science:** Flow Visualization Techniques in classroom Introduce the "crown challenge"	Milk and Dye Class
11 (Week 6)		Discussion of art and physics of images → Editing	
12		**Science:** Clouds	Reading
13 (Week 7)		**Photography:** Clouds	Clouds
14		Discussion of art and physics of images	
15 (Week 8)		Redo and earlier assignment - compare and contrast	Redo Assignment
16		Discussion of art and physics of images	
17 (Week 9)		**Science:** External Flow and Tracking (Smoke, particles)	Reading
18		**Photography:** Florescent dye in darkness → Lab	Particle Tracking
19 (Week 10)		**Photography:** Florescent dye in darkness → Lab	Particle Tracking
20		Discussion of art and physics of images Introduce Final Project	
21 (Week 11)		**Science:** heat convection → Lab	Heat Convection
22		Discussion of art and physics of images	
23 (Week 12)		**Science:** Index of Refraction Discussion / Drops → Lab	Index of Refraction
24		Discussion of art and physics of images	
25 (Week 13)		**Science:** Vortex Flow → Lab	Vortex Flow
26		Discussion of art and physics of images "crown challenge" Presentation	
27 (Week 14)		Thanksgiving break - No class	
28		Thanksgiving break - No class	
29 (Week 15)		Redo an assignment – discussion, compare, and report.	Redo Assignment
30		Final Project Work Period	
31 (Week 16)		Final Project Work Period	
32		**Final Presentation in Gaige Lobby**	Project and Crown
Week 17		No Final Exam	

COURSE REQUIREMENTS

Course Management System:
This course has a **Canvas** site. Included on the site are the syllabus, announcements, lectures, and exam solutions. Homework problems, reading assignments, and HW solutions can be found on **McGraw Hill Connect** website.

Class Attendance & Participation: Your final grade can be affected due to poor attendance and lack of participation in class. **You will be asked to drop the course if you miss more than four classes, otherwise you will receive "F".** You must contact your instructors prior to any anticipated class absence. It is the responsibility of the student to find out what was presented in a class session that they missed.

Use of Electronic Devices: The use of cell phones, MP3 players, laptops, etc. is prohibited during class time. Disorderly will not be tolerated. Failure to abide by these rules could result in being asked to leave the class, resulting in an absence for the session. No electronic devices that store information or have the capability to connect to the Internet are permitted during the quiz and exam (i.e., no cell phones).

Late Work: All assignments are due at the beginning of class. Work will be considered late as soon as lecture/class begins. **Late submission will not be accepted** except for legitimate reason submitted **prior to** due date.

Make-Up Quizzes and Exam: No make-up quizzes or exams will be given except as required by University Policy 42-23. You must contact your instructors **prior to** any anticipated quiz or exam absence to arrange a makeup. If you are sick, notify your instructors by email.

Getting help with homework: Working on homework problems is the key to learning the concepts—each person is expected to complete all of their own work, but collaboration can also be a useful tool. Copying, however, is prohibited. It is absolutely PERTINENT that each student work through and think through each homework problem. If you need additional help, please come to the office hours. You will not receive any credit for your homework if you copy the solutions manual.

Grading and Scale:

Homework:	**50**	%
Quizzes:	**10**	%
Projects:	**20**	%
In-Class Activities:	**10**	%
Attendance:	**10**	%

93.00%	-	100.00%	--->	A
90.00%	-	92.99%	--->	A-
87.00%	-	89.99%	--->	B+
83.00%	-	86.99%	--->	B
80.00%	-	82.99%	--->	B-
77.00%	-	79.99%	--->	C+
70.00%	-	76.99%	--->	C
65.00%	-	69.99%	--->	D
0.00%	-	64.99%	--->	F

** Adjustments to these assigned values are at the discretion of the instructor.* ***There will be no extra credit available.***

UNIVERSITY POLICIES

Academic Integrity: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

Student Disability Resources: Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. Please contact Michelle Peasley, Student Disability Resources Coordinator, at mns136@psu.edu or 610-396-6410. Her office is located in 169 Franco. For further information, please visit the Student Disability Resources Website: http://equity.psu.edu/student-disability-resources
In order to receive consideration for reasonable accommodations, you must contact Michelle Peasley, participate in an intake interview, and provide documentation: http://equity.psu.edu/student-disability-resources/guidelines . If the documentation supports your request for reasonable accommodations, the Student Disability Resources at Penn State Berks will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

Counseling and Psychological Services: Counseling and Psychological Services staff work with thousands of Penn State students per year in group therapy, individual counseling, crisis intervention, and psychiatric services as well as providing prevention, outreach, and consultation services for the University community. Services at CAPS are designed to enhance students' ability to fully benefit from the University environment and academic experience. Penn State Berks Counseling Services are located in Suite 10 of the Perkins Student Center - Phone: 610-396-6082.

STUDENT RESPONSIBILITY FOR LEARNING

The faculty, administration, and staff of Penn State Berks believe that learning is a team effort, and we work diligently to fulfill our obligations, inside and outside the classroom. Students, however, are the most vital part of this effort. Since you have made the decision to come to college, you have made the simultaneous choice to be responsible for your academic success. What does taking responsibility for learning mean?

- it means that you attend class regularly and arrive on time.
- it means that you complete all assignments on time.
- it means that you understand that each instructor has different requirements and expectations, that you read each syllabus carefully to discern each instructor's requirements and expectations, and that you abide by the instructor's requirements and expectations.
- it means that you participate actively in class.
- it means that you put forth considerable time and effort in your academic work and that you turn in work that reflects your time and effort.
- it means that you take advantage of the college's resources (such as the learning center, writing center, library workshops, technology workshops) to ensure that your skills are at the levels they need to be for college work.
- it means that you continuously assess your progress in each class and immediately take steps to address any deficiencies or weaknesses.
- it means that you accept the consequences when you do not meet your responsibilities as a student.

PENN STATE VALUES

- **INTEGRITY**: we act with integrity in accordance with the highest academic, professional, and ethical standards.
- **RESPECT**: we respect and honor the dignity of each person, embrace civil discourse, and foster a diverse and inclusive community.
- **RESPONSIBILITY**: we act responsibly and hold ourselves accountable for our decisions, actions, and their consequences.
- **DISCOVERY**: we seek and create new knowledge and understanding, and foster creativity and innovation, for the benefit of our communities, society, and the environment.
- **EXCELLENCE**: we strive for excellence in all our endeavors as individuals, an institution, and a leader in higher education.
- **COMMUNITY**: we are Penn State, one university geographically dispersed, committed to our common values and mission, working together for the betterment of the university and the communities we serve and to which we belong.