

**1. Name of the college or university seeking the approval of the course.**

University of Cincinnati

Course Number: PD2030; It will be cross listed with BIOL when ordered for the Fall 2019

Course Title: Inquiry to Innovation: Animals and Robots- Biology Meets Engineering

Credits: 3 semester hours

**2. Person requesting course to be considered for Level I.**

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**3. Description of why having access to this particular course would benefit College Credit Plus students as a Level I course.**

The course is part of a National Science Foundation Innovative Technology Experiences for Students and Teachers grant. It focuses on developing this trans-disciplinary education model. The course will benefit students by providing cross-disciplinary *preparation, orientation* and *access*.

*Preparation:* The course increases college readiness by introducing fundamental concepts across disciplines: engineering, biology, math, and physics. It provides students interested in pursuing any of these fields with a unique preparatory advantage. Second, trans-disciplinary instruction advances basic cognitive abilities, enhances the ability to recognize bias, think critically, and tolerate ambiguity. These skills benefit students transitioning into higher education and/or the workforce.

*Orientation:* About a third of students in STEM fields switch majors before graduating. This course engages students in multiple domains and presents an opportunity to explore these domains before committing to a degree path. The course will fulfill a UC College of Arts and Sciences General Education requirement in Natural Sciences, and a University-level requirement in Technology and Innovation. Thus, the course will count toward virtually any degree or certificate program of study.

*Access:* This course is both timely and needed. Approximately 80% of jobs in next decade will require math and science skills. However, STEM job growth is outpacing the size of the qualified workforce and cross disciplinary training is needed to fill the demand. The biological sciences and engineering are undergoing revolutionary changes and much of this is due to the integration and mutual inspiration of the two fields, and a major driving force in many sectors of the economy.

**4. Electronic copy of the course syllabus.**

Attached.

**Inquiry to Innovation: Animals and Robots- Biology Meets Engineering**  
**PD2030; 3 Credits**  
**Fall 2019**

**Course instructors:**

**Dr. John Layne**

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**Dr. Stephanie M. Rollmann**

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**Dr. Dieter Vanderelst**

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**Course location and time:** TBD

**Office Hours:** By appointment and TBD

**Overview:**

Complex behavior is often assumed to require a large brain. However, many animals can get by just fine with relatively simple brains, or no brain at all, and can deal with challenging and unpredictable changing environments. For example, ants continuously expand their large and complex nests. Female crickets find mates hidden in the grass by homing in on their calls. Honey bees can discover nectar sources by following the directions given to them by their sisters. Research has revealed a common theme uniting these feats: small-brained animals use specialized sensory organs in combination with simple behavioral rules. This surprising elegance of nature's solutions increasingly inspires roboticists to look to animals for solutions to engineering challenges. For example, flying robots are piloted using the same principles as flying insects while other robots navigate their environment in the same way as ants, bats or fish.

Taught by a team of interdisciplinary instructors, this course will introduce students to the exciting interface of biology with robotics, and instill the fundamentals of how behavior is guided by senses, in both animals and robots. The course lays out foundational concepts of sensory guidance and advances into more complex behavior. In particular, the students will gain an understanding of how biology can inform robotics and *vice versa*. We will also explore the principles underlying the organization of animal societies and evaluate their utility as inspiration for so-called swarm robotics. Through team-based projects, students will apply their gained skills and knowledge to the design and testing of both single and multi-robot systems.

**Learning outcomes:**

1. Describe the basic properties of light, sound, and chemical stimuli in the world.
2. Understand how biological and human-made sensors detect and process stimuli.
3. Demonstrate an understanding of the limitations of human-made sensors as compared with biological sensory organs.
4. Demonstrate an understanding of common behavioral strategies found in animals that are guided by sensory systems.
5. Be able to provide examples of biological principles exploited by robots, and their advantages.
6. Be able to provide examples of how robots are used to test hypotheses about animal behavior.
7. Display competence in diverse means of measurement, analysis, and representation in research.

**Transferable skills:**

1. Critical thinking: Analysis of complex issues and formulation of insightful solutions.
2. Teamwork and collaboration: Work in teams to achieve improved results in team projects.
3. Scientific method/Engineering design process: Generate hypotheses and develop innovative projects to test and improve hypotheses.
4. Oral communication: Verbal sharing and comparisons of project progress/outcomes.

**Prerequisites:**

There are no prerequisites. High school students are expected to have completed a course in the natural sciences, engineering and/or information technology at a grade level of C or above.

**Course text:**

No course text is required. Course documents will be posted on Blackboard.

**Reference books:**

Books are on reserve in the University of Cincinnati library for class use.

Alcock, J. 2013. *Animal Behavior: An Evolutionary Approach* 10<sup>th</sup> edition. Oxford University Press. Cary, NC. ISBN: 978-0878939664.

Bekey, G.A. 2005. *Autonomous Robots: From Biological Inspiration to Implementation and Control*. MIT Press. Cambridge, MA. ISBN: 978-0262534185.

Niku, S.B. 2011. *Introduction to Robotics: Analysis, Control, Applications*. 2<sup>nd</sup> edition. John Wiley & Sons, Inc. Hoboken, NJ. ISBN: 978-0470604465.

Purves, D. et. al. 2017. *Neuroscience*. 6<sup>th</sup> edition. Sinauer Associates. Sunderland, MA. ISBN: 978-1605353807.

Raven et al. 2017. *Biology*. 11<sup>th</sup> edition. McGraw Hill Education. New York, NY. ISBN: 978-1259188138.

Smith, C.U.M. 2009. Biology of Sensory Systems. 2<sup>nd</sup> edition. John Wiley & Sons, Inc. Hoboken, NJ. ISBN: 978-0470518632.

**Attendance/General Statements:**

The course meets twice a week. Attendance and participation is expected. Exams will cover material provided in the lecture and in the textbook. Lecture slides will be posted on Blackboard to facilitate augmenting your own notes. Cell phone use is not permitted at during class or exams. No formal points will be awarded for class participation.

**Grading Policy:**

Exams: There will be four exams of equal value. The exams will not be comprehensive but may require you to have knowledge of material from the previous exam period. The material to be covered on each exam will consist of lecture material as well as assigned readings. Calculators will not be allowed during the exam, unless otherwise stated. There will be no extra-credit assignments. If you have a verifiable excuse (e.g., medical, death in family) for missing an exam, see the section on Makeup policy below.

Project: Students will work in teams to complete a final project. Drawing on the skills and knowledge obtained during the course, the students will build a robot solving a challenge inspired by real-world applications. Challenges could be drawn from timely domains such as self-driving cars, autonomous transportation, search and rescue, disaster robots or security robots. Students will perform a computational analysis of the challenge at hand. Next, the students will identify biological strategies that could serve as an inspiration. Finally, students will engage in an iterative design process typical for experimental robotics: they will select sensors and actuators, refine their robotic platform and progressively develop the necessary software. Each project will culminate in a group 3-minute video, produced in collaboration with UC media services. In the video, the students will explain the challenge their robot addresses, its biological inspiration, its architecture, and operation.

Regrade Policy: Exams may be submitted for a regrade within three working days of return of exam. To have an exam regraded, it must be written in ink on a cover page that outlines the specific issues regarding the way the exam was graded. The instructor(s) reserve the right to regrade the entire exam, not just the individual questions requested for reconsideration.

Policy on Incompletes: A grade of Incomplete (I) will be assigned only in those cases when a student has completed the bulk of the work for the course, cannot continue because of unforeseen circumstances, and arranges prior to the final exam to complete any unfinished work.

The final class grade will be determined on a standard grading scale to be posted on Blackboard (A, B, C, D, F, including plus and minus grades) as follows:

Exam 1	15%
Exam 2	15%
Exam 3	15%
Exam 4	15%
<u>Project</u>	<u>40%</u>

Total

100%

Once final grades are assigned, there will be no adjustments (except in the case of a clerical error).

**Emergency Cancellation Policy:**

If this class must be cancelled due to an emergency (different from an entire-university weather-related closing), the cancellation will be posted as an announcement on Blackboard and sent out via email as soon as possible. It is your responsibility to ensure that your correct email address is registered with Blackboard. If an exam is scheduled to be held on a day in which classes are cancelled (emergency or a university weather related closing), the exam will take place during the next class period.

**Makeup Policy:**

Make-up exams will not be given unless there is a medical or family emergency; in these instances, notification from a doctor or other appropriate authority will be required in writing and it will be verified. The student must notify the instructor by or on the day of the exam that he/she is unable to take the test. The make-up exam must be taken within three weekdays of the originally scheduled time and will consist of a different test on the same subject matter. A score of zero will be given to students with an invalid or non-verifiable absence, or who do not contact the instructor within the required time period.

**Plagiarism:**

Plagiarism is representing someone else's work as your own and is considered academic misconduct at the University of Cincinnati. Any final document submitted that contains plagiarism will receive a failing grade. The easiest way to avoid plagiarism is to cite your sources. The University of Cincinnati has a tutorial on understanding what constitutes plagiarism and how to avoid it here: <http://guides.libraries.uc.edu/preventplagiarism>

**Counseling Services, Clifton Campus:**

Students have access to counseling and mental health care through the University Health Services (UHS), which can provide both psychotherapy and psychiatric services. In addition, Counseling and Psychological Services (CAPS) can provide professional counseling upon request; students may receive five free counseling sessions through CAPS without insurance. Students are encouraged to seek assistance for anxiety, depression, trauma/assault, adjustment to college life, interpersonal/relational difficulty, sexuality, family conflict, grief and loss, disordered eating and body image, alcohol and substance abuse, anger management, identity development and issues related to diversity, concerns associated with sexual orientation and spirituality concerns, as well as any other issue of concerns. Students may call UHS at 513-556-2564 or CAPS Cares at 513-556-0648. For urgent physician consultation after-hours students may call 513-584-7777.

**Title IX:**

Title IX is a federal civil rights law that prohibits discrimination on the basis of your actual or perceived sex, gender, gender identity, gender expression, or sexual orientation. Title IX also covers sexual violence, dating or domestic violence, and stalking. The university does not

tolerate sex discrimination, sexual harassment, or retaliation and takes steps to ensure that students, employees, and third parties are not subject to a hostile environment in university programs or activities. If you disclose a Title IX issue to me, I am required to forward that information to the UC Title IX Office. They will follow up with you about how the University can take steps to address the impact on you and the community and make you aware of your rights and resources. Their priority is to make sure you are safe and successful here. You are not required to talk with the Title IX Office. If you would like to make a report of sex or gender-based discrimination, harassment or violence, or if you would like to know more about your rights and resources on campus, you can consult the website [www.uc.edu/titleix](http://www.uc.edu/titleix), directly contact the UC Title IX office at 556-3349.

### **Accessibility and Universal Design for Learning:**

UC is committed to providing all students equal access to learning opportunities. Accessibility Resources is the official campus office that works with students who have impairments which may influence their performance in this course (learning, ADD, psychological, visual, hearing, physical, cognitive, medical condition, etc.). If you have a documented disability requiring reasonable accommodations, please consult the Accessibility Resources website <https://www.uc.edu/aess/disability.html> or contact them at 556-6823.

If you do not have a documented disability, other support services in the Learning Commons (<https://www.uc.edu/learningcommons.html>), including the Academic Writing Center (<https://www.uc.edu/learningcommons/writingcenter.html>), are available to all students.

UC is committed to the ideal of universal Web accessibility and strives to provide an accessible Web presence that enables all university community members and visitors full access to information provided on its websites. Every effort has been made to make these pages as accessible as possible in accordance with the applicable guidelines. Visit the website <https://www.uc.edu/inclusion/oeoa.html> for more information on policies and resources at the University of Cincinnati.

### **College of Arts and Sciences (A&S) Academic Integrity Two Strikes Policy:**

As with all A&S efforts, this course will uphold the highest ethical standards, critical to building character. Ensuing your integrity is vital and your responsibility. A&S instructors are required to report any incident of academic misconduct (e.g., cheating, plagiarism) to the college review process, which could result in severe consequences, including potential dismissal from the college. For further information on Academic Misconduct or related university policies and procedures, please see the UC Student Code of Conduct (<http://www.uc.edu/ucinfo/conduct.html>).