BEAM 4985: The Neuroscience of Superpowers

I. Catalog Description:

This course is an applied systems neuroscience course, with extensive focus on comparative biology and biomechanics. Comic book super powers will be used as a motivation to 1) compare physiology, nervous systems, and behavior across Animalia, and 2) survey current technological developments that may help modify human physiology and nervous systems.

Students will learn the nervous system roles and locomotor system components required to achieve a particular behavior with a given body form. Students will learn about current bioengineering and neuroengineering methods and techniques, and exercise researching these fields. Finally, students will gain practice in science communication, by participating in managing the course twitter account and blog, with the aim of communicating to readers with a high school education.

II. Learning Objectives

Upon completion of BEAM 4985, students will be able to:

- Compare physiology and nervous systems of a singular behavior between species
- Research behavioral functions across organisms, to aide in bioinspired design
- Describe basic control/nervous system demands for a given behavioral function and physical form
- Understand population and timing encoding in nervous systems, and examples of both
- Identify limitations of control, based on constraints of nervous and physical systems
- Research current bioengineering developments for specific applications.

III. Justification

Learning justification: There is a growing need for interdisciplinary understanding of physiology, neurobiology, and biomechanics for applications in bioinspired engineering and medical design. This class provides a novel engagement of problem-solving and provides structure as to how to make the requisite research explorations to effectively solve problems in engineering and medical developments.

Level justification: This course requires application of knowledge, and ability to apply learned knowledge over rote memorization. This course is multi-disciplinary in nature, requiring application of engineering to novel biological systems. This class thus requires upper-level problem solving skills and knowledge assimilation for success.

IV. Prerequisites and Co-requisites

Because this is a course designed primarily for students with an engineering background, fundamental biology and neurobiology to understand neural control and biomechanics will be covered within the course. The course will also be made accessible to students in other programs such as Biology and Neuroscience.

V. Text and Special Teaching Aids

Required text:

Squire, Berg, Bloom, du Lac, Ghosh, Spitzer, *Fundamental Neuroscience, 4th Edition*, Elsevier Inc., 2013.

Recommended text:

Würtz Rolf P. *Organic Computing.* Berlin: Springer, 2008.

VI. Syllabus

General neurobiology	10%
Technological developments	10%
Muscle and physical form physiology	30%
Neural networks	25%
Neural encoding	10%
Neural recording	5%
Ethics of human modification	10%
TOTAL	100%

LEARNING OBJECTIVES/ELEMENTS	**PROGRAM OUTCOMES**				
	1	**2**	**3**	**4**	**5**
Compare physiology and nervous (control) systems of a singular behavior between species	1		3		
Research behavioral functions across organisms, to aide in bioinspired design	1	2			
Describe basic control/nervous system demands for a given behavioral function and physical form	1	2			
Understand population and timing encoding in nervous systems, and examples of both	1	2			
Identify limitations of control, based on constraints of nervous and physical systems	1		3		
Research current bioengineering developments for specific applications	1	2			

1 – Major emphasis of course
2 – Discussed in the course, and covered in homework or quiz
3 – Discussed in the course, but not covered in homework or quiz