BIOL/ME 4740 Biologically Inspired Design (Elective)

Catalog Description: BIOL/ME 4740 Biologically Inspired Design (3-0-3)

Prerequisites: BIOL 1520 Introduction to Organismal Biology or BIOL 3600 Introduction to Evolutionary Biology or BMED 3100 Systems Physiology or PHYS 2211 Introduction to Physics I or permission of instructor

Crosslisted with BIOL, BMED, ISyE, ME, MSE, and PTFE.

We examine evolutionary adaptation as a source for engineering design inspiration, utilizing principles of scaling, adaptability, and robust multifunctionality that characterize biological systems.

Textbook: Steven Vogel, *Cat's Paws and Catapults*, W. W. Norton & Company, 2000.

Topics Covered:

1. Introduction to bio-inspired design, course content/expectations
2. Evolution and functional "design" of organisms
3. Design process
4. Structural photonics
5. The creative process
6. Hierarchical structures
7. Green chemistry
8. Systems organization
9. Locomotion: control, balance, gait
10. Sensors and movement
11. Perception: natural sensors, optimal sensors
12. Green building
13. Industrial ecology

Course Outcomes:

Outcome 1: Students will gain a basic understanding of biological principles relevant to engineering design.

- 1.1 Students will practice analogizing between biological and engineering functions in order to learn how to identify biological systems that may meet specific engineering design goals.
- 1.2 Students will learn how biologists describe functions that are analogous to engineering functions in order to facilitate their ability to mine biological literature for potential engineering design solutions.
- 1.3 Students will examine specific case studies of successful application of biological principles in key areas.
- 1.4 Students will perform in-depth quantified analyses aimed at understanding the physical principles governing specific biological principles.

Outcome 2: To allow students to place the engineering process into a larger (biological, societal) context.

- 2.1 Students will learn to see the biological world as sources of design solutions and inspiration.
- 2.2 Students will be motivated to examine the impact of their design ideas on the environment.
- 2.3 Students will examine how biological systems solve problems analogous to those of human built systems with less reliance on scarce/toxic materials and with lower energy expenditure.

2.4 Students will learn to apply engineering tools and techniques to an understanding of biological function in order to improve our understanding of biological processes.

Outcome 3: To provide students with a systematic approach to biologically inspired design based on a variety of design methods that permit the consideration and incorporation of a different design options.

3.1 Students will learn conceptual frameworks for thinking about the design process, such as problem decomposition techniques, structure-behavior-function metrics and other tools for analogical based reasoning.

3.2 Students will demonstrate their ability to formulate specifications and functional requirements for open ended design problems based on customer needs and physical reality.

3.3 Students will demonstrate their ability to consider multiple biologically inspired design alternatives and identify the best possible choice based on the design specifications.

Outcome 4: To enhance a student's ability to communicate at personal and technical levels, in both oral and written fashions.

4.1 Students will give oral presentations relating to work accomplished pertaining to the class project.

4.2 Students will provide written homework and reports detailing their capability of quantitative analyses and design developments.

4.3 Students will have the opportunity to talk to and interact with industry other end users of the design process.

Outcome 5: To enable students to work in self-managed teams.

5.1 Students will demonstrate the ability to work in teams by researching, developing and analyzing biologically inspired designs as well as documenting the designs in written and oral reports.

5.2 Students will have work effectively with team members with extremely different skill sets and backgrounds, and in particular, will learn to engage those who understand biological systems, e.g. student teams include a mixture of engineers from a variety of disciplines as well as biologists with little experience in engineering designs or methodology.

Correlation between Course Outcomes and Student Outcomes:

ME 4740											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1			X		X			X	X	X	
Course Outcome 1.2	X	X	X	X			X	X	X		
Course Outcome 1.3	X	X		X					X		X
Course Outcome 1.4	X				X						X
Course Outcome 2.1			X					X		X	X
Course Outcome 2.2	X		X		X	X		X	X		
Course Outcome 2.3	X	X				X		X	X	X	X
Course Outcome 2.4	X							X	X	X	X
Course Outcome 3.1	X		X		X				X		X
Course Outcome 3.2	X		X		X				X	X	X
Course Outcome 3.3	X		X		X	X	X	X	X	X	X

Course Outcome 4.1			X	X			X				X
Course Outcome 4.2	X		X	X			X	X			X
Course Outcome 4.3			X	X		X	X	X	X	X	X
Course Outcome 5.1	X		X	X	X		X	X	X		X
Course Outcome 5.2		X		X			X	X		X	

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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