

## **Biologically Inspired Design Biol 4740**

- 3 Credit Hours
- 1.5 hours, 2 times per week

### **Grades:**

- 20% : Homework and quantitative assignments (12)
- 20% : class participation, guest lecture assignments
- 60% : Final Project
  - (10% : 1st presentation)
  - (25% : Final presentation)
  - (25% : Final paper)

### **Biologically Inspired Design (BID)**

This course is cross-listed in Biology, Industrial and Systems Engineering, Polymer, Textile and Fiber Engineering, Materials Science Engineering, and Mechanical Engineering. Students will learn about a variety of biomimetic methods and ongoing research projects. Final projects will involve a team of students from different disciplines. Each team will select a design problem, develop a biological analogy to the problem, learn about pertinent biological structures, processes, or systems, and produce a report or design that is biologically inspired. We begin with lectures and activities, to introduce students to biomimicry, followed by case studies of bio- inspired applications in science and engineering. We conclude with presentations of design projects produced by interdisciplinary teams of students presented in the language of interdisciplinarity.

### **Course Structure**

The course has the following primary elements along with their described goals:

- **Introduction to Bio Inspired Design (BID).** Give an introduction to basic concepts in biology and of engineering design. Demonstrate the potential utility of BID. Show past uses of BID. Gain experience in understanding how biological and man- made objects function the way they do.
- **Topics in Bio Inspired Design.** This portion of the course consists of a series of guest lectures covering varied topics within BID. This portion serves two purposes. The primary purpose is to give practice in assimilating new information from various fields. The ability to listen, understand, and apply is important as a deep technical understanding. A secondary purpose is to also give exposure to the varied applications of BID.
- **Team Design Project.** The team design project is a synthesis of all the primary goals of the course. A good project requires identifying relevant technical challenges, performing an effective search for natural systems that solve the appropriate technical challenges, understanding the technical challenges faced by natural systems, performing thorough technical analysis and comparison to existing designs, and generating innovative design ideas, all while using bio-inspiration in the design process. You will have a faculty facilitator to aid you in focusing your project, and there will be meeting rooms set aside for you to work in.

<u>DATE</u>	<u>TOPIC</u>	<u>DISCUSSION OF READINGS (TU)</u>	<u>WRITTEN ASSIGNMENT; IN-CLASS ACTIVITY (TH)</u>
Week 1,	Intro to bio inspired design, course content/expectations	Case Studies. Biological vs Human Solutions.	Solution vs. problem driven approaches <b>HW1: found object</b>
Week 2,	Evolution and rate of innovation	Nature as mentor, source of inspiration. <b>HW2: data forms</b>	SBF framework <b>HW3: Design Challenges</b>
Week 3,	Design Process.	Requirements, abstraction, process.	Problem decomposition <b>HW4: Quantitative assignment 1</b>
Week 4,	Structural photonics.	Bio inspired OPTICS	Design synthesis: Revisit Found Objects <b>HW5: Product innovation</b>
Week 5,	The creative process	Representation and Analogical thinking	Problem definition and design effectiveness exercise
Week 6,	1 <sup>st</sup> presentation 1 <sup>st</sup> presentation	<b>Design critique</b>	<b>Design critique</b> <i>Assessment 1</i>
Week 7,	Hierarchical structures.	Scale dependent properties.	Object decomposition <b>HW6: Structural found object</b>
Week 8,	Green chemistry	Fall Break: Oct. 8, 9	Green Chemistry Lecture <b>HW7: Quantitative assignment 2</b>
Week 9,	Systems Organization	Bees as a model.	Object decomposition <b>HW8: Optimized found object</b>
Week 10,	Locomotion: Control, balance, gait	Bio-inspired robotics.	Object decomposition <b>HW9: Locomotion found object</b>
Week 11,	Sensors and movement	Bio-inspired navigation on uneven terrain	<b>HW10: Quantitative assignment 3</b>
Week 12,	Perception: Natural sensors, Optimal sensors	Bio inspired sensors Camouflage, stealth	Object decomposition <b>HW11: Sensors found object</b>
Week 13,	Green building	Solar decathlon/Green building	Industry challenges <b>HW12: Reflections</b>
Week 14	Industrial ecology	Sustainability/Natural Capitalism	<b>Thanksgiving</b>
Week 15,	<b>Final presentations</b>	<b>Final Presentations</b>	<b>Final Presentations</b>
Week 16,	<b>Final presentations</b>	<b>Final Presentations</b> <i>Assessment 3</i>	<b>Final Presentations</b> <b>Final products due.</b>