

BIO/ISYE/ME/MSE/PTFE 4740 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:

1. **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.
2. **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.
3. **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.

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

			HW12: Reflections
Week 14	Industrial ecology	Sustainability/Natural Capitalism	Thanksgiving
Week 15,	Final presentations	Final Presentations	Final Presentations
Week 16,	Final presentations	Final Presentations <i>Assessment 3</i>	Final Presentations Final products due.

Biologically Inspired Design (3cr, 1.5 h x 2/wk)

Biol 4803A, ISyE 4803E, ME 4803D, MSE 4803B, PTFE 4803A

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)