

ME 599 004/ROB599 002 WN 2021 BioInspiration

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Instructor:

Talia Y. Moore

Teaching Assistant: Xun Fu

Course Format:

Online (at least until the pandemic ends)

Lectures will be synchronous over Zoom to encourage interaction 2:30-3:30pm Tuesday and Thursday.

Lectures will be recorded and posted to canvas for asynchronous interaction via Perusall.

Labs will include self-guided tutorials and at-home activities explained during Tuesday lab sessions 3:30-4:30pm.

Office hours will be during Thursday lab sessions 3:30-4:30pm.

Prerequisites:

None. Just bring your open mind, fun questions, and creative ideas.

Textbook:

None.

Rationale:

Nature is full of biological organisms that are specialized for specific tasks. By examining the process by which natural selection shapes biological forms, we can learn from nature to inspire technological design. This course will explore biological strategies for swimming, flying, terrestrial locomotion, adhesion, sensing, and construction. This will be an interdisciplinary endeavor with team-based robotic design projects.

Communication:

- Announcements will be through Canvas.
- All assignments will be posted and submitted via Canvas
- This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Sign up link: piazza.com/umich/winter2021/me599004rob599002wn2021bioinspiration

Bioinspired Design Projects:

Students will be mailed kits to complete hands-on design projects that will have both individual- and team-based components.

1. Design a bio-inspired gripper based on an open-source prosthetic hand design.
 2. Test a legged robot. Assemble and modify a legged robot and measure its performance. Then use the robot as a design tool to propose a new product.
 3. Design a soft robotic actuator. Create a basic pneumatically actuated Fiber-Reinforced Elastomeric Enclosure. Then use the actuator as a design tool to propose a new product.
 4. Create a Gecko-inspired adhesive. In the first session, teams will manufacture a gecko inspired adhesive and analyze the adhesive. In the second design session, teams will either use their gecko-inspired adhesive as a design tool to propose a new product or suggest ways to improve the adhesive.
4. Novel Bioinspired Design. The final exam will be a 5 min video of a bioinspired design of your team's choice. Teams will select a journal publication with a biological discovery and extract the principle. Teams will then create a mock-up, prototype, and/or computer simulation/animation in combination with the setting in which your design is to be used. Designs should include possible societal impacts (health, fitness, environment, safety, security, education, connections to others or community, assisting underserved, disabled populations or underdeveloped countries, sports and entertainment). Funds are available to procure additional materials if you wish to make a physical prototype. The video must be posted to the assignment page in Canvas by midnight on April 20th. (You will NOT have a written exam.)

Surveys:

You will be asked to participate in a series of surveys and self-reports to help improve the course. Surveys relating to the design projects will be included in the project grade. Surveys relating to the course overall will be anonymous and will be included in the participation grade.

Extra Credit r/BioInspiration Subreddit:

Links to relevant BioInspiration articles should be posted to [reddit.com/r/bioinspiration](https://www.reddit.com/r/bioinspiration) (<http://www.reddit.com/r/bioinspiration>)

One point for any of these options:

- Post a link about Biology that could become Technology
- Post a link about Technology that was inspired by Biology
- Post a link about a group of people working on BioInspiration
- Comment on 3 other links with meaningful discussion

Grading:

- 5% Class Participation (or Perusall Interaction) and surveys
- 20% Midterm (in-class multiple choice)
- 10% Discovery Decompositions
- 5% Team Gripper Project
- 10% Team Legged Robot Project
- 10% Team Soft Robot Project
- 10% Team Gecko Project

- 30% Team Final Design Project (5 min team video)
- Extra points for subreddit!

Our absolute scale is 100-90 A; 90-80 B; 80-70 C; 70-60 D; <60 F.

Academic accommodations:

Please make certain that you contact the Office of Services for Students with Disabilities at least 2 weeks before the midterm so that we can make accommodations.

Policies:

Honor code:

We expect students to act in accordance with the University of Michigan Engineering Honor code, available in the sidebar.

Exam:

The exam will be an at-home midterm administered on Canvas. We will not administer a make-up midterm exam. If you have to miss an exam for a valid, unforeseeable and urgent reason, your grade will be pro-rated. If you do find yourself facing an unforeseen emergency, please contact us as soon as possible to let us know. Documentation will be required. Please note: this policy is for valid emergencies. Students are otherwise expected to complete all assignments. While we will remind you about exam logistics, you are responsible for making sure that you complete every question.

Design assignments:

Only a documented illness or some other unforeseeable emergency will allow us to grant you a due date for a design assignment that is later than what is posted on this syllabus or in a Canvas Announcement. Anticipated events do not count as acceptable reasons for turning in your assignment late as you can and should plan ahead and turn your assignment in early. If your assignment is late, please still submit as soon as possible. You will lose a point for each day late.

Lecture interaction:

Interaction during synchronous lectures can be in the form of speaking or typing in the zoom chat. You will not be graded on the content you post on Piazza. Asynchronous interaction with recorded lectures can be performed using the Perusall tool.

Discussion/Lab interaction:

Interaction with discussion and lab materials can be performed using Perusall. We encourage you to use the designated lab time on Tuesday to complete the tutorials for the week, and to use the designated lab time on Thursday to meet with your team.

Recording lectures:

Lectures are comprised of copyrighted intellectual material, and the sharing of that material without express permission is a violation of copyright and personal privacy. Additionally, the discussion of sensitive issues in this class requires that students feel safe to express their opinions without fear of future reprisal or exposure. Students caught sharing course materials will be asked to leave the class. In addition, it is a violation of copyright to sell notes, assignments or exams to on-line companies.









Schedule:






Date	Lecture	Lab/Discussion	Assignment
Jan 19	Introduction	Explain Surveys and CAEN software	Do Surveys
Jan 21	BioDiscovery - How to discover nature's principles?		



Jan 26	BioDesign - How do I design from nature?	Literature Search, Latex	Discovery Decomposition, Make CV, Subreddit username
Jan 28	BioConstraints - How are Nature's designs compromised?		
Feb 2	BioSelection - How do I select the best inspiration?	Teaming Tools, CAD	Gripper Design
Feb 4	BioScaling - How do I consider size?		
Feb 9	BioComplexity - How to simply and extract principles?	Midterm Q&A	Midterm
Feb 11	BioMotion - Walking		
Feb 16	BioMotion - Running	Kinematics, Smart Composite Materials, Origami Robots	Kamigami Assembly
Feb 18	Creature Feature - Jerboas		
Feb 23	BioPower - Nature	Experimental Design	Kamigami Test
Feb 25	BioPower - Technology		
Mar 2	Creature Feature - Snakes	Soft Robots	FREE Assembly
Mar 4	BioControl		
Mar 9	BioSensing	Statistics	FREE Design
Mar 11	BioNavigation		
Mar 16	BioMaterials	Gecko Lab	Gecko Adhesive, Final Project: Discovery Decomposition
Mar 18	BioAdhesion		
Mar 23	BREAK	BREAK	Gecko Design
Mar 25	Creature Feature - Geckos		
Mar 30	BioMotion - Swimming	Figure Design, Media Training	Final Project: Analogy and Collaborative Pla
Apr 1	BioMotion - Flying		

Apr 6	BioAssembly - Swarms	Adobe Premiere	Final Project
Apr 8	BioAnimation		
Apr 13	BioProsthetics	Networking	Final Project
April 15	Summary		
April 20	Design Showcase	Design Showcase	Video





Course Summary:








Date	Details	
Tue Jan 19, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=997997&include_contexts=course_420172)	2:30pm to 3:30pm
	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998394&include_contexts=course_420172)	3:30pm to 4:30pm
Thu Jan 21, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=997998&include_contexts=course_420172)	2:30pm to 3:30pm
	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998411&include_contexts=course_420172)	3:30pm to 4:30pm
Tue Jan 26, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=997999&include_contexts=course_420172)	2:30pm to 3:30pm
	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998395&include_contexts=course_420172)	3:30pm to 4:30pm
Thu Jan 28, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998000&include_contexts=course_420172)	2:30pm to 3:30pm
	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998412&include_contexts=course_420172)	3:30pm to 4:30pm

Date	Details
Tue Feb 2, 2021	 BiInspiration Lecture 2:30pm to 3:30pm
	 BiInspiration Lab 3:30pm to 4:30pm
	 Anonymous Pre-Survey due by 11:59pm
	 Building Teams Survey due by 11:59pm
	 Discovery Decomposition 1 due by 11:59pm
Thu Feb 4, 2021	 Mailing Address for Kits due by 11:59pm
	 BiInspiration Lecture 2:30pm to 3:30pm
Tue Feb 9, 2021	 Talia Office Hours 3:30pm to 4:30pm
	 BiInspiration Lecture 2:30pm to 3:30pm
Thu Feb 11, 2021	 BiInspiration Lab 3:30pm to 4:30pm
	 BiInspiration Lecture 2:30pm to 3:30pm
	 Talia Office Hours 3:30pm to 4:30pm
Tue Feb 16, 2021	 BiInspiration Midterm Exam W2021 due by 11:59pm
	 BiInspiration Lecture 2:30pm to 3:30pm
	 BiInspiration Lab 3:30pm to 4:30pm

Date	Details
	 Project: BioInspired Gripper https://umich.instructure.com/courses/420172/assignments/1222091 due by 11:59pm
Thu Feb 18, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998006&include_contexts=course_420172 2:30pm to 3:30pm
	 Talia Office Hours https://umich.instructure.com/calendar?event_id=998415&include_contexts=course_420172 3:30pm to 4:30pm
Tue Feb 23, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998007&include_contexts=course_420172 2:30pm to 3:30pm
	 BioInspiration Lab https://umich.instructure.com/calendar?event_id=998399&include_contexts=course_420172 3:30pm to 4:30pm
	 Discovery Decomposition 2 https://umich.instructure.com/courses/420172/assignments/1226281 due by 11:59pm
Thu Feb 25, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998008&include_contexts=course_420172 2:30pm to 3:30pm
	 Talia Office Hours https://umich.instructure.com/calendar?event_id=998416&include_contexts=course_420172 3:30pm to 4:30pm
Tue Mar 2, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998009&include_contexts=course_420172 2:30pm to 3:30pm
	 BioInspiration Lab https://umich.instructure.com/calendar?event_id=998400&include_contexts=course_420172 3:30pm to 4:30pm
	 Project: Kamigami Robot Design https://umich.instructure.com/courses/420172/assignments/1222088 due by 11:59pm
Thu Mar 4, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998010&include_contexts=course_420172 2:30pm to 3:30pm
	 Talia Office Hours https://umich.instructure.com/calendar?event_id=998417&include_contexts=course_420172 3:30pm to 4:30pm
Tue Mar 9, 2021	 BioInspiration Lecture https://umich.instructure.com/calendar?event_id=998011&include_contexts=course_420172 2:30pm to 3:30pm

Date	Details
	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998401&include_contexts=course_420172) 3:30pm to 4:30pm
	 Discovery Decomposition 3 (https://umich.instructure.com/courses/420172/assignments/1226285) due by 11:59pm
Thu Mar 11, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998012&include_contexts=course_420172) 2:30pm to 3:30pm
	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998418&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Mar 16, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998013&include_contexts=course_420172) 2:30pm to 3:30pm
	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998402&include_contexts=course_420172) 3:30pm to 4:30pm
	 Project: Soft Robot Design (https://umich.instructure.com/courses/420172/assignments/1223421) due by 11:59pm
Thu Mar 18, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998014&include_contexts=course_420172) 2:30pm to 3:30pm
	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998419&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Mar 23, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998015&include_contexts=course_420172) 2:30pm to 3:30pm
	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998403&include_contexts=course_420172) 3:30pm to 4:30pm
	 Final Project: Discovery Decomposition (https://umich.instructure.com/courses/420172/assignments/1226283) due by 11:59pm
Thu Mar 25, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998016&include_contexts=course_420172) 2:30pm to 3:30pm
	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998420&include_contexts=course_420172) 3:30pm to 4:30pm

Date	Details
Tue Mar 30, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998017&include_contexts=course_420172) 2:30pm to 3:30pm
Tue Mar 30, 2021	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998404&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Mar 30, 2021	 Project: Gecko-Inspired Adhesive Design (https://umich.instructure.com/courses/420172/assignments/1222085) due by 11:59pm
Thu Apr 1, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998018&include_contexts=course_420172) 2:30pm to 3:30pm
Thu Apr 1, 2021	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998421&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Apr 6, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998019&include_contexts=course_420172) 2:30pm to 3:30pm
Tue Apr 6, 2021	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998405&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Apr 6, 2021	 Final Project: Analogy Check and Collaborative Plan (https://umich.instructure.com/courses/420172/assignments/1222083) due by 11:59pm
Thu Apr 8, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998020&include_contexts=course_420172) 2:30pm to 3:30pm
Thu Apr 8, 2021	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998422&include_contexts=course_420172) 3:30pm to 4:30pm
Tue Apr 13, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998021&include_contexts=course_420172) 2:30pm to 3:30pm
Tue Apr 13, 2021	 BiInspiration Lab (https://umich.instructure.com/calendar?event_id=998406&include_contexts=course_420172) 3:30pm to 4:30pm
Thu Apr 15, 2021	 BiInspiration Lecture (https://umich.instructure.com/calendar?event_id=998022&include_contexts=course_420172) 2:30pm to 3:30pm
Thu Apr 15, 2021	 Talia Office Hours (https://umich.instructure.com/calendar?event_id=998423&include_contexts=course_420172) 3:30pm to 4:30pm

Date	Details
Mon Apr 19, 2021	 Final Video Project due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1222084)
Tue Apr 20, 2021	 BioInspiration Lecture 2:30pm to 3:30pm (https://umich.instructure.com/calendar?event_id=998023&include_contexts=course 420172)
Tue Apr 20, 2021	 BioInspiration Lab 3:30pm to 4:30pm (https://umich.instructure.com/calendar?event_id=998407&include_contexts=course 420172)
Fri Apr 23, 2021	 Anonymous Design Project Feedback Survey due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1241420)
Fri Apr 23, 2021	 Anonymous Lecture Feedback Survey due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1241419)
Fri Apr 23, 2021	 Anonymous Post-Survey due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1241409)
Fri Apr 23, 2021	 Lecture Interaction due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1224290)
Fri Apr 23, 2021	 r/BioInspiration Extra Credit due by 11:59pm (https://umich.instructure.com/courses/420172/assignments/1222093)