

CEE4560 Syllabus

Origami Engineering, 3.0 credit hours

TR, 4:30PM-5:45PM, Mason 3133

Instructor Information

Instructor Glaucio H. Paulino	Email paulino@gatech.edu	Office Hours & Location Fridays 12:00-1:00pm Mason 5124B (or by appointment)
Guest Instructor Wes Wynens	Email wes.wynens@gatech.edu	Office Hours & Location By appointment
Teaching Assistant(s) Tuo Zhao	Email tzhao43@gatech.edu	Office Hours & Location Wednesdays 12:00pm – 1:00pm Mason 1201B (or by appointment)
Class Ambassador Kushal Shankar	Email kushalshankar@gatech.edu	Office Hours & Location Mondays 4:00 pm – 5:30 pm Mason 1201B (or by appointment)

The “Class Ambassador” is someone who took the class before and acts as a mentor to the current students.

General Information

Description

This class acquaints the student with the state-of-art concepts and algorithms to design and analyze origami structures. Students will learn how to create and transform geometries by folding and unfolding, and thus apply origami to solve engineering and societal problems. In addition, using origami as a tool, we will outreach to some fundamental concepts in differential geometry.

Leadership Development Component

This course is an approved elective in the Global Engineering Leadership Minor (GELM). As such, it incorporates a leadership development component. In this course that component is team-building. The team-building component is integrated into the course instruction and deliverables, so even students who are not part of the leadership minor will participate in these activities. The class involves a final project, in which the students use what they have learnt in the class to design and prototype origami-inspired solutions to engineering and/societal problems. The students assemble small teams (up to 4 people) which are intellectual diverse in the sense that at most 2 students of the same major are allowed in a team. Prof. Wes Wynens teaches 3 classes related to introduction to teams & teaming, proposal debriefing, and presentation preparation.

Pre- &/or Co-Requisites

Math 1552 (Integral Calculus), Math 1553 (Introduction to Linear Algebra), and Junior or Senior Standing

Course Goals and Learning Outcomes

Upon successful completion of this course, you should be able to know the following topics:

- Application of OE (Origami Engineering) to solve societal problems
- Team building and communication, development of individual awareness

- Origami design principles
- Origami mechanics
- Polyhedra folding and unfolding
- Spherical trigonometry

Course Requirements & Grading

Assignment	Date	Weight (Percentage, points, etc)
Participation		20% (i-Clickers + in-class participation, bonus problems)
Homework		20% (see HW Collaboration & Group Work)
Midterm Exam	11/20	30%
Final project		30%

Extra Credit Description

During the semester, there will be several open problems. If the students can find solutions to the problems in a given amount of time, they can earn extra credit.

Description of Graded Components

- Participation --- 20% (i-Clickers + in-class participation, bonus problems/assignments)
- Homework --- 20% (see HW Collaboration & Group Work)
- Midterm --- 30%
- Final project --- 30%
In the final project, the students will use what they have learnt in the class to design and prototype origami-inspired solutions to engineering and/societal problems. The students will be divided into small groups (**3-4 people**). Due to the intellectual diversity of our class, each group should have members of at least 2 different majors (groups in which all the members belong to the same major will not be allowed). *Students should be pro-active in finding an appropriate group.* Each group is expected to provide the following deliverables:
 - Proposal: explanation of goal(s), work plans, and how the team is organized and how it addresses a social need/problem (5%).
 - Presentations (in class): should address the technical aspects of the project and how it addresses a social problem/need (10%).
 - Project report (7%): brief introduction, development and lessons learned
 - "Trade show" (open to public): each group should promote their "product" (prototypes of design) (8%).

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Course Materials

Course Text

J. O'Rourke (2011). *How to Fold It*. Cambridge University Press. Website: <http://howtofoldit.org/>.

Additional Materials/Resources

T. Hull (2012). *Project Origami: Activities for Exploring Mathematics, Second Edition*. CRC Press.

R. Lang (2011). *Origami Design Secrets: Mathematical Methods for an Ancient Art*. CRC Press.

M. Schenk (2011). *Folded Shell Structures*. University of Cambridge, PhD thesis.

Electronic version: <http://www.markschenk.com/research/files/PhD%20thesis%20-%20Mark%20Schenk.pdf>

Course Website and Other Classroom Management Tools

- http://paulino.ce.gatech.edu/Origami_Course/origamiengineering_index.html,
usr: origamiengineering, pswd: Miura2018
- <http://paulino.ce.gatech.edu> or www.ghpaulino.com
- i-Clicker: <https://www.iclicker.com>
- GroupMe (class group): <https://www.groupme.com>
- WhatsApp (class group): <https://www.whatsapp.com>

Course Expectations & Guidelines

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Attendance and/or Participation

Attendance and punctuality are basic requirements for an effective discussion and team based course. Beyond that, each person's frequency and quality of contribution to the class discussion will be assessed and reflected in the class participation score. If you cannot attend a class, it is a courtesy to inform your group or team members and your professor in advance if possible. Participation counts 20% in the final grade. It includes i-Clicker activities (principal activity) plus in-class participation, solution of selective bonus problems/assignments, etc. Participation scores will be provided frequently to the students and updated during the semester. *Please refrain from using cell-phone during class.*

HW Collaboration & Group Work

Collaboration on homework is encouraged. However, you should think about the problems yourself before discussing them with others. Furthermore, you must write up your solutions by yourself and understand anything that you hand in. If you do collaborate, you must acknowledge your collaborators in your write-up.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

GIT policies will be followed regarding exams, assignments, extensions, late assignments, etc.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Student Use of Mobile Devices in the Classroom

As research on learning shows, unexpected noises and movement automatically divert and capture people's attention, which means you are affecting everyone's learning experience if your cell phone, pager, laptop, etc. makes noise or is visually distracting during class. With this in mind, you are allowed to take notes on your laptop, but I request that you turn the sound off so that you do not disrupt other students' learning.

Lab Safety

Georgia Tech has recently revised its policy regarding appropriate clothing in laboratories where chemicals and organisms are used or manipulated. Students not conforming with the following requirements will be asked to leave the lab to acquire appropriate clothing: 1. Long pants must be worn in the laboratory. 2. Close-toed shoes that cover the sides and top of the foot must be worn in the laboratory. 3. Lab coats must be worn when working at the bench. Students are responsible for keeping their lab coats in good condition and reasonably clean so as to not create a hazard. Lab coats must be 100% cotton and cover the wearer to the knees. 4. Safety glasses must be worn when working at the bench. Safety glasses must have side shields for splash protection and conform to the wearer's face. Glasses must be worn over prescription glasses and contact lenses. Safety glasses will be available for your use in the lab.

Students can purchase appropriate lab coats at the VWR store in the Ford EST Building.

Campus Resources for Students

- Georgia Tech library
- Origami Engineering Lab (Mason 4130)
- Innovation Center (MRDC)
- School of Architecture design lab

Course Schedule

Class #	Date	Reading before class	Topic during class	Homework/Project	Assignment Due
1	8/21/2018	Online Videos	Introduction (state-of-art applications, tools)	HW1	
2	8/23/2018	Part II	Rigid origami ("LEGO")		
3	8/28/2018		Introduction to teams & teaming [Dr. Wes Wynens]		

Class #	Date	Reading before class	Topic during class	Homework/ Project	Assignment Due
4	8/30/2018	Part II-4.1,4.2,4.3	Origami design-Maekawa-Justin theorem		
5	9/4/2018	Part II-4.4,4.5	Origami design-Kawasaki-Justin theorem	Project discussion	
6	9/6/2018	Schenk Thesis 4.1.1	Miura-ori (Silhouette Cameo)	HW2	HW1
7	9/11/2018	Exercise/handout Science Adv. Paper	Miura-ori & derivatives		
8	9/13/2018	Schenk Thesis 4.1.2	The Eggbox pattern		
9	9/18/2018	PNAS paper	Origami tubes		
10	9/20/2018	Handout, PNAS paper	Origami metamaterials	HW3	HW2
11	9/25/2018	Handout	Gauss map and Gaussian Curvature		
12	9/27/2018	Exercise	Non-rigid origami (bending of Miura-ori and Eggbox)		
13	10/2/2018	Handout	Bar and hinge model: basics		
14	10/4/2018	Handout	Bar and hinge model: MERLIN software	HW4	HW3
15	10/9/2018	Fall Student Recess			
16	10/11/2018		Proposal Debriefing [Dr. Wes Wynens]		Project Proposal
17	10/16/2018	Handout	Lab tour and training		
18	10/18/2018	Handout	Spherical trigonometry	HW5	HW4
19	10/23/2018	Handout	Explore differential geometry using origami		
20	10/25/2018	Handout	Pop-up cards: foldability		
21	10/30/2018		Guest Lecture		
22	11/1/2018	Part II-5	Fold and one-cut (hands-on exercise)		HW5
23	11/6/2018	Part II-5.1	Fold and one-cut (theory)		
24	11/8/2018	Part II-6	The shopping bag theorem, part 1		
25	11/13/2018	Part II-6	The shopping bag theorem, part 2		
26	11/15/2018		Origami review		

Class #	Date	Reading before class	Topic during class	Homework/ Project	Assignment Due
27	11/20/2018		Midterm		
28	11/22/2018		Thanksgiving Break		
29	11/27/2018	Part III-7.1	Polyhedra-edge unfolding (hands-on exercise)		
30	11/29/2018		Presentation Prep. [Dr. Wes Wynens]		
31	12/4/2018	Part III-7.2	Polyhedra-edge unfolding (theory)		Project report
32	12/11/2018		Project presentation [2:00pm-4:00pm]		ppt file & poster
32	12/11/2018		"Trade Show" [4:00pm-5:30pm]		

NOTE: Notice that the time that has been scheduled for our FINAL EXAM (December 11th, 2:40pm-5:30pm) will be used for both "Project Presentation" and "Trade Show" activities. You are required to be physically present from 2:40pm-5:30pm, however, if you or members of your group could start the activities earlier (i.e. from 2:00pm), that would be nice!