ME 8710: Engineering Optimization

CRN 84739 – Location Online

Professor: Cameron J. Turner, Ph.D., P.E.
Office: 206 Fluor Daniel Building
Phone: 864.656.2413 (office)
E-mail: cturne9@clemson.edu
Class: Online, Asynchronous
Office Hours: MWF 9-10 or by Appointment via Zoom

Course Description:

Optimization in the context of engineering design; nonlinear and linear, static and dynamic, constrained and unconstrained formulation and solution of practical problems; structural optimization; multi-objective optimization; genetic algorithms; simulated annealing.

Textbooks:

(Encouraged) Papalambros, P. and Wilde, D. (2017). "Principles of Optimal Design: Modeling and Computation", Cambridge University Press, Cambridge, United Kingdom.

(Supplemental) Venkataraman, P. (2002). "Applied Optimization with MATLAB Programming", John Wiley and Sons, Inc., New York, New York, USA.

(Supplemental) Jenson, P. and Bard, J. (2003). *Operations Research Models and Methods*, John Wiley and Sons, Inc.: Hoboken, New Jersey, USA.

Expectations:

Students are expected to develop and optimize models for systems used in design and engineering, subject to realistic constraints. Through this course, students will:

1. Students will know the various optimization approaches currently available
2. Students will program several methods to understand the trade-off between efficiency and programming complexity
3. Students will be able to set up optimization problems and solve them
4. Students will know which algorithm can be used for a specific problem type
5. Students will know how to use commercial optimization codes and couple them with analysis codes
6. Students will know when to use approximation methods to reduce the computational burden

Submissions:

Unless otherwise stated, all submissions will be made electronically through Canvas. Assignments that are late are penalized 10% per day or portion thereof. ***It is almost always to your benefit to submit an assignment late rather than to not submit an assignment at all.*** The Special Circumstance grading policy applied to Spring 2020 will not be employed during the Fall 2020 semester.

Weighting for Grade:

Category	Description	Percentage
Packback	Weekly evaluations of the questions asked, and comments made	10%
Homework	~8 assignments, individually completed	50%
Term Project	Semester Project (done in teams)	20%
Peer Evaluation	Evaluation of your project performance by your team	5%
Final Exam	The solution to an individual optimization problem (30-days provided)	15%
	Total	**100%**

If this were a private professional setting, grades should be taken to reflect the following standards:

A Exceptional performance, worthy of an immediate promotion.

B Outstanding performance. Continued delivery of work meeting this standard will lead to promotion.

C Satisfactory performance, however, continued development of professional or technical skills is necessary for promotion to become a consideration.

D Unsatisfactory performance with flawed professional or technical skills. Further training is essential to determine if a continued investment in the employee is justified.

F Unsatisfactory performance with unacceptable professional or technical skills. Immediate termination is necessary.

Attendance

The course will be delivered asynchronously with recorded videos provided each week to cover the material presented that week. Course meeting times (MWF 9:05-9:55) will be used for discussion and office hours on Zoom where students may ask questions of Dr. Turner (except as announced by Dr. Turner). Additional office hours are available by appointment. Assignments are due at 11:59PM on the date specified unless otherwise specified. If there is a campus closure that affects these deadlines, they will be updated in Canvas as soon as possible. If you have a problem that prevents you from submitting an assignment (e.g. home internet outage) you should notify Dr. Turner via email ASAP.

Make-up Work

1. Students should speak with their course instructors regarding any scheduled absence as soon as possible and develop a plan for any make-up work.
2. In the event of an emergency, the student should make contact with the course instructor via e-mail as soon as possible. It is the student's responsibility to secure documentation of emergencies, if required.
3. Once make-up accommodations are communicated to the student, they should be acknowledged in email by the student.

Office Hours

Because of COVID-19 and my status as an at-risk individual, I will be holding office hours via Zoom (Join URL: https://clemson.zoom.us/j/97944660012). At a minimum, I will be available MWF from 9-10AM unless otherwise announced. Additional appointments are also possible via email request. Use of this time and participation in Packback are encouraged to enable instructor-student interactions.

COVID-19 Policies

Response to a Presumptive Positive or Positive COVID-19 Test:

For a student who reports testing positive or is being asked to quarantine/isolate because of exposure to the virus, it will be up to the student to inform the instructor that they will be moving to online-only instruction for at least the next two weeks. Students are directed to use the Notification of Absence module in Canvas to initiate this notification. Additional communication via email is encouraged; students should follow up with their instructor to develop a continued plan of study for each course. Students cannot be penalized in their grade for needing to move to online instruction.

Instructors and students who are informed that they have a presumptive positive diagnosis or have tested positive for COVID-19 should immediately self-isolate and submit the COVID-19 Positive Test Reporting Form, see https://www.clemson.edu/coronavirus/index.html.

Academic Continuity Plan:

Clemson has developed an Academic Continuity Plan for academic operations. Should university administration officially determine that the physical classroom facility is not available to conduct classes in, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email and social media. When notified, use one of the following links to navigate to Clemson Canvas where you will find important information about how we will conduct class:

- Primary access link: www.clemson.edu/canvas
- Secondary access link, if needed: https://clemson.instructure.com/
- You can also use the Canvas Student App.

COVID Emergencies

In the event of a regional or national emergency (e.g., pandemic, hurricane, etc.), students missing classes may not be charged with unexcused absences if the nature and extent of the emergency is defined and disseminated by the Provost (or designee).

Notification of Absences

The Notification of Absence module in Canvas allows students to quickly notify instructors (via an email) of an absence from class and provides for the following categories: court attendance, death of family member, illness (or COVID-19 related isolation), illness of family member, injury, military duty, religious observance, scheduled surgery, university function, unscheduled hospitalization, other anticipated absence, or other unanticipated absence. The notification form requires a brief explanation, dates and times. Based on the dates and times indicated, instructors are automatically selected, but students may decide which instructors will receive the notification. This does not serve as an "excuse" from class, and students are encouraged to discuss the absence with their instructors. If a student is unable to report the absence electronically, he/she may call the Office of Advocacy and Success at 656-0935 for assistance and guidance.

The Office of Advocacy and Success also assists students in identifying various appropriate methods of documenting absences and assists families in using the electronic Notification of Absence system when students are unable to do so themselves.

Incompletes and Medical Withdrawals

Issuing an "Incomplete" grade (I) to a student is an option if a student is unable to complete make-up work in a timely manner due to COVID-19 related illness or other issues. An Incomplete indicates that a relatively small part of the semester's work remains undone. It is not intended for students who are failing a course otherwise. In the event that an Incomplete is appropriate, students will contact instructors in a timely manner so that instructors can provide a reasonable opportunity to complete remaining work. Instructors and students will work together to resolve the Incomplete grade as soon as possible, not to exceed thirty days from the first day of classes in the next scheduled session (excluding summer sessions and regardless of the student's enrollment status).

Sometimes due to illness (including COVID-19 related illness) or other life circumstances, students may not be able to complete academic work for the term and will need to withdraw from all classes.

Students can use iROAR to add courses through August 25, to drop courses without record through September 1, and to drop with a W grade through October 23, 2020.

Software

Students may complete the optimization problems using algorithms in C++, MATLAB, ModeFrontier and other programs as specified within the assignments. Some problems may also require students to use available CAD/CAE software packages. Computing technology questions may be sent to ITHELP@clemson.edu.

Ethical Behavior

Ethical behavior and professional standards are expected in this class. Fundamentally, this class is governed by the NSPE Code of Professional Ethics . Note that all work submitted is to be that of the individual student unless cooperative effort is specifically authorized. In the case of team assignments, ALL team members are responsible for the work submitted by the team. The College of Engineering, Computing and Applied Science Honor Code and the Clemson University Student Handbook will be observed. Refer to your student handbook regarding University policies on academic dishonesty. ***Any copying, plagiarism, or other unethical behavior will be referred to the appropriate authorities and a failing grade will be earned by the offending student.***

Academic Integrity

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity.

Title IX Policy

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

The University is committed to combatting sexual misconduct. As a result, you should know that University faculty and staff members who work directly with students are required to report any instances of sexual discrimination, including harassment and sexual violence, to the University's Title IX Coordinator. What this means is that as your professor, I am required to report any incidents of sexual discrimination that are directly reported to me, or of which I am somehow made aware.

Accessibility Statement

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the instructor know and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their instructors as early

in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: http://www.clemson.edu/campus-life/campus-services/sds/.

Packback

Participation is a requirement for this course, and the Packback Questions platform will be used for online discussion about class topics. Packback Questions is an online community where you can be fearlessly curious and ask open-ended questions to build on top of what we are covering in class and relate topics to real-world applications. CCIT cannot provide assistance with Packback. Any issues should be directed to help@packback.co.

Packback Requirements:

Your participation on Packback will count toward 10% of your overall course grade. There will be a Weekly Monday at 12:00AM EST deadline for submissions. In order to receive your poins per week, you should submit the following per each deadline period:

- 1 open-ended Question per week each worth 5pts of each assignment grade
- 2 Responses per week each worth 5pts of each assignment grade

How to Register on Packback:

An email invitation will be sent to you from help@packback.co prompting you to finish registration. If you don't receive an email (be sure to check your spam), you may register by following the instructions below:

1. Create an account by navigating to https://questions.packback.co and clicking "Sign up for an Account" Note: If you already have an account on Packback you can log in with your credentials.
2. Then enter our class community's lookup key into the "Looking to join a community you don't see here?" section in Packback at the bottom of the homepage.
   Community Lookup Key: **b3f49de6-2e3c-4a88-958b-7fbc51477e9f**
3. Follow the instructions on your screen to finish your registration.

Packback is also connected via the Canvas site. Packback may require a paid subscription (~$25). Refer to www.packback.co/product/pricing for more information.

How to Get Help from the Packback Team:

If you have any questions or concerns about Packback throughout the semester, please read their FAQ at help.packback.co. If you need more help, contact their customer support team directly at help@packback.co.

For a brief introduction to Packback Questions and why we are using it in class, watch this video: vimeo.com/packback/Welcome-to-Packback-Questions

Copyright Statement

Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in a particular course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Tech Act. Students should be reminded to refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy on the Clemson University website. Additional information is detailed at http://libguides.clemson.edu/copyright.

Course Schedule:

The initial course schedule is attached. It may be updated as necessary during the semester. Updates will be posted on Canvas.

Engineering Optimization - Fall 2020 (CRN 84739)

Virtually Delivered
Asynchronous Class
Version 1.0

Week	Lecture	Date	Day	Topics	Assignment	Due	Notes
1	1	19-Aug	Wednesday	Class Overview and Introduction			
	2	21-Aug	Friday	Graphical Solution Methods	Homework #1		
2	3	24-Aug	Monday	Linear Programming			8/25 Last Day to Register
	4	26-Aug	Wednesday	Simplex Algorithm		Homework #1	
	5	28-Aug	Friday	Primal & Dual Problems - Sensitivity Analysis			
3	6	31-Aug	Monday	Linear Programming Applications	Homework #2		9/1 Last Day to Drop without Penalty
	7	2-Sep	Wednesday	Constrained Nonlinear Optimization			
	8	4-Sep	Friday	Monotonicity Analysis	Term Project Assignment		
4		**7-Sep**	**Monday**	**Labor Day - No Class**			**9/8 Last Day to Apply for Graduation**
	9	9-Sep	Wednesday	Activity of Constraints		Homework #2	
	10	11-Sep	Friday	Monotonicity Tables	Homework #3	Term Project Teams Due	
5	11	14-Sep	Monday	Unconstrained Nonlinear Optimization (1D)			9/13-9/18 Move-in Week
	12	16-Sep	Wednesday	General Unconstrained Optimization			9/13-9/18 Move-in Week
	13	18-Sep	Friday	Penalty Functions			9/13-9/18 Move-in Week
6	14	21-Sep	Monday	Penalty Functions (continued)	Homework #4	Homework #3	
	15	23-Sep	Wednesday	Constrained Gradient Methods		Term Project Proposals	
	16	25-Sep	Friday	Karush-Kuhn-Tucker (KKT) Conditions			
7	17	28-Sep	Monday	Sequential Programming and Reduced Gradient Methods	Homework #5	Homework #4	
	18	30-Sep	Wednesday	Discrete Variables		Term Project Approval	
	19	2-Oct	Friday	Multi-objective (Pareto) Optimization			10/4 Deadline to Register to Vote in SC
8	20	5-Oct	Monday	Dominance Tables	Homework #6		
	21	7-Oct	Wednesday	ModeFrontier		Homework #5	
	22	9-Oct	Friday	ModeFrontier			9/9 Midterm Grades Due
9	23	12-Oct	Monday	MDO: Multi-Disciplinary Optimization		Term Project Literature Survey	
	24	14-Oct	Wednesday	State Space Optimization			
	25	16-Oct	Friday	Informed State Space Optimization	Homework #7	Homework #6	
10	26	19-Oct	Monday	Simulated Annealing			
	27	21-Oct	Wednesday	Evolutionary and Genetic Algorithms			
	28	23-Oct	Friday	MOGA: Multi-Objective Genetic Algorithms			10/23 Last Day to Withdraw
11	29	26-Oct	Monday	Topology Optimization	Homework #8	Homework #7	
	30	28-Oct	Wednesday	Topology Optimization			
	31	30-Oct	Friday	Surrogate Models: Response Surfaces		Term Project Status Update	
12		**2-Nov**	**Monday**	**Fall Break - No Class**			**11/2-11/3 Fall Break & 11/3 Election Day**
	32	4-Nov	Wednesday	Tradespace Optimization			Spring 2021 Registration Opens
	33	6-Nov	Friday	Principles and Practices of Optimization			
13	34	9-Nov	Monday	Final Exam Introduced	Final Exam Presented	Homework #8	
	35	11-Nov	Wednesday	No Lecture - Project Days			
	36	13-Nov	Friday	No Lecture - Project Days			
14	37	16-Nov	Monday	No Lecture - Project Days			
	38	18-Nov	Wednesday	No Lecture - Project Days			
	39	20-Nov	Friday	No Lecture - Project Days			
15	40	23-Nov	Monday	No Class - Project Day		Term Projects Due 11/24 @5PM	11/24 Last Day of On Campus Courses
		25-Nov	**Wednesday**	**Thanksgiving Break - No Class**			**11/25-11/27 Thanksgiving Break**
		27-Nov	**Friday**	**Thanksgiving Break - No Class**			
16	41	30-Nov	Monday	Term Project Presentations		Term Peer Evaluations Due	
	42	2-Dec	Wednesday	Term Project Presentations			
	43	4-Dec	Friday	Term Project Presentations		Presentation Reviews Due	Last Class Day - No Exams
17		***7-Dec***	***Monday***				***12/7-12/11 Final Exam Week***
		9-Dec	***Wednesday***			***Final Exam Due 12/9***	***12/7-12/11 Final Exam Week***
		11-Dec	***Friday***				***12/7-12/11 Final Exam Week***
18		***14-Dec***	***Monday***				***Candidate Grades Due 9AM***
		16-Dec	***Wednesday***				***All Grades Due 9AM***
		17-Dec	***Thursday***				***Graduation Fall 2020***