

Material Selection and Failure Analysis

EMA4714 Sections
(Class 12584, T P6-7, R P7)
(Class 21184, T P6-7, R P6)

Class Periods: Tuesday Lectures T6-7, Thursday Labs R6 & 7
Location: Lecture: Matherly Hall 0005, Lab: RHINES B06 & 115
Academic Term: Spring 2024

Instructor:

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Office Hours: Tue/Thu, 12-1 pm Room TBD Rhines Hall

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- TA:TBD
- Office: TBD
- Office Hours (TBD)

Course Description

Philosophy and practice of engineering selection of materials.
Case studies in product liability and failure analysis
3 Credits

Course Pre-Requisites / Co-Requisites

EMA4223 & 4324 (Recommended but not required)

Course Objectives

If a scientist invents it's often up to the engineer to implement. Implementation could range from a single component or application to high volume application (millions) each presenting challenges and opportunities in design and function. Materials engineers, regardless of their individual discipline, will be required to select the right material for the right application at the right time from a large list of manufacturing options from which to fabricate a component or an assembly. The design process can involve an existing specification or require an entirely new design based on the intended performance and properties. Additionally, the manufacturing process must be taken into account to ensure quality, reliability and durability of the final product. As part of various class projects, you will also be required to integrate functionality into your analysis to understand what it is that the component is supposed to do with respect to the total service environment. There is also be a subset of design considerations which derive from microstructural changes associated with materials processing - forming, molding, heat treating, tempering, annealing and changes from the application of wear and friction reducing coatings. Add to this other design constraints such as cost, time, materials availability, environment concerns, etc., and the simple problem becomes a challenge. Lectures will cover a number of materials selection and developments in industry including but not limited to: materials substitution, materials innovation, materials invention, materials process development and the importance of securing intellectual property.

This course is intended to expose the student to use of the design methodology from which a procedure can be implemented which will lead to the selection of the optimum material for the particular application being considered. By the time you will have completed this course, you will be able to:

1. Describe, conceptually, analytically and via reverse engineering, how system components work and to model function or performance using scientific and engineering principles learned as part of your undergraduate education.
2. Participate in integrated design and/or failure analysis activities using fundamentals of “systems engineering”, where performance and behavior have to be analyzed in light of product performance, consumer expectations, durability, and reliability of the design.
3. Gain experience in the selection of materials and optimization of behavior by using a systematic methodology which combines materials properties with the engineering function of the process or product design.
4. Present and justify materials selection effectively both orally and in written form.
5. Select and use appropriate industrial literature and library resources in the solution of materials selection and failure analysis problems. An important element in your thinking will include common sense.
6. Lectures (Tuesdays) will be both in-person as well as on-line following a hybrid design to ensure social distancing and any potential COVID19 safety protocols should they arise in 2024. Laboratory class (Thursdays) will follow dept and University required protocols for safe laboratory participation with use of personal protective equipment including masks, gloves and limited in-person attendance to ensure social distancing.

Materials and Supply Fees

Materials will be provided for laboratory experiments with the lab class organized into student groups based on your area of focus (Metals, Ceramics, Polymers, Biomaterials and Electronics). Lab fees are posted to on-line to purchase the necessary consumables and personal protective equipment required for COVID protection protocols.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Class lectures
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (Medium)	Material selection assignment will be used to assess engineering design and selection via completion of literature search, development of quad charts, timing charts, one- page executive summaries and select business case studies as requested by instructor.
3. An ability to communicate effectively with a range of audiences (High)	Students will present to class oral presentations of quad charts and executive summaries, presenting technical details of a project in a clear and concise manner
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the	Class Lectures include detailed business ESG topics including business case examples in Aerospace, Automotive and Industrial applications.

impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (High)	Laboratory will consist of students grouped into areas of common interest (metals, ceramics, polymers, biomaterials, electronics). Year-end group presentations will assess teamwork and progress.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Class Lectures
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Class Lecture materials

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Recommended Textbooks and Materials

- Engineering Design
- 5th edition
- George E. Dieter
- Linda C. Schmidt
- McGraw Hill [2009]
- ISBN 978-0-07-339814-3
- ASM Handbooks (1-20)
- **Materials Selection and Design** ASM International [1997]
- Materials Selection in Mechanical Design", Pergamon Press [1992] by M.F. Ashby.

Course Schedule (Tentative – Tuesday Lectures)

Week 1:	Introduction to Materials Selection / Class organization for Lab
Week 2:	Design Process (Engineering Design)
Week 3:	Project Management
Week 4:	Defining the Problem
Week 5:	Gathering Information
Week 6:	Material Substitution (Steel – Al)
Week 7:	Materials Selection Quad Charts/Exec Summary
Week 8:	Materials Innovation (Agri-Bio Materials)
Week 9:	Materials Invention (Material by design)
Week 10:	Materials Process Development (Plastics Processing)
Week 11:	Integrated Computational Materials Engineering (ICME)
Week 12:	ORNL – CF and ICME
Week 13:	Supplier Joint Development (BASF – Nylon/CF composites)
Week 14:	Team Presentations
Week 15:	Team Presentations
Week 16:	TBD

Attendance Policy, Class Expectations, and Make-Up Policy

State whether attendance is required and if so, how will it be monitored? What are the penalties for absence, tardiness, cell phone policy, laptop policy, etc. What are the arrangements for missed homework, missed quizzes, and missed exams? This statement is required: Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework- as needed	100 each	20%
Midterm Reviews	100	30%
Final Presentation	100	50%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history,

academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another

and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.