Material Selection and Failure Analysis

EMA4714 Sections (2983 – 2992)
Class Periods: Tuesday Lectures T6-7, Thursday Labs R5-9
Location: Lecture: WERT 360, Lab: RHINES B06 & 115
Academic Term: Spring 2021

Instructor:
Matthew J Zaluzec "DrZ"
mzaluzec@mse.ufl.edu
Office Phone/Cell: 734 796-6752
Office Hours: (TBD) Tue/Thu, 12-1 pm Room 252 Rhines Hall

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website

- Appajosula Yashodhara Rao "Yashu"
- arao1@ufl.edu
- (301) 467-6013

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

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 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 COVID19 safety protocols. 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, Bio-Materials 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 impact of engineering solutions in global, economic, environmental, and societal contexts	Class Lectures
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, bio-materials, 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 Lectures

*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

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

F2F Course Policy in Response to COVID-19

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms.
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies.

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.aa.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.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

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
- Hebert Wertheim College of Engineering Human Resources, 352-294-7977, mse-hr@eng.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/.

Academic Resources

E-learning technical suppor*t*, 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.