

## EMA4324 Fall 2015

### Standardized Syllabus for the College of Engineering

1. Catalog Description (3 credits) – Mechanisms, energetics and kinetics of corrosion and degradation of engineering materials. Economic solutions to degradation problems based upon design and materials selection.
2. Pre-requisites and Co-requisites: Prereq: EMA4314
3. Course Objectives: To understand the stability of materials and the supporting fundamental theories. To apply content knowledge to real world applications of stability in engineering. To apply knowledge to solve problems and design systems or materials to improve stability in real applications.
4. Contribution of course to meeting the professional component: This is a 3 credit course. It provides 3 credits towards engineering sciences.
5. Relationship of course to program outcomes: This course addresses the following MSE Student Learning outcomes, and the following ABET outcomes (note: Numbers refer to the list of MSE Program outcomes):
  1. Apply knowledge of mathematics, science and engineering principles to materials science and engineering.
  2. Design and conduct materials science and engineering experiments and analyze and interpret the data.
  3. Design a materials science and engineering system, component or process to meet desired needs within realistic economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability constraints.
  4. Communicate technical data and design information effectively in speech and in writing to other materials engineers.

#### ABET

- (e) an ability to identify, formulate, and solve engineering problems
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Instructor: Dr. Nancy Ruzycki
  - a. Office location: RHN 135A
  - b. Telephone: 352.846.2991
  - c. E-mail address: nruzycki@mse.ufl.edu
  - d. Office hours: Thursdays 4<sup>th</sup> period – 10:40 – 11:30 AM

7. Teaching Assistant: none
8. Meeting Times: Monday \_Wednesday\_Friday 3<sup>rd</sup> period 9:35 -10:25
9. Class schedule: lecture three times a week for one hour
10. Meeting Location: Lecture – CSE E220

[https://classrooms.at.ufl.edu/classroom-info/pictures-and-info/#prettyPhoto\[CSE\]/3/](https://classrooms.at.ufl.edu/classroom-info/pictures-and-info/#prettyPhoto[CSE]/3/)

11. Materials and Supply Fees: none

12. Textbooks and Software Required: “The Principles and Prevention of Corrosion”, Denny A. Jones, Prentice Hall; 2<sup>nd</sup> Edition, 978-0133599930. Matlab/Origin/Granta Software access in Rhines 115

13. Recommended Reading: Ebook (UF Libraries) “Chemical Thermodynamics of Materials : Macroscopic and Microscopic Aspects”; Author: Stølen, Svein, Grande, Tor, John Wiley & Sons, 2004

14. Course Outline: Below is the tentative schedule of topics, activities, reading assignments, exams, and homework. See Canvas for Module and Unit Objectives, Learning Outcomes, assignments, and rubrics. This outline is subject to change.

Module number	Content/concepts	Student activities
1  Weeks 1 (1 lecture)  <b>Developing definitions for stability of materials</b>	What is stability? How does it differ within materials categories?  Micro and macroscale stability  Developing a model of stability as it related to materials science applications	Student article review on stability for each material category. <b>(SP)</b>
2  <b>Developing a vocabulary for stability of materials – Thermodynamics</b>  Weeks 1, 2 (5 lectures)	First and Second law of Thermodynamics  Fundamental equations of Thermodynamics  Enthalpy and Entropy  Gibbs Energy  Chemical Equilibrium & Chemical Potential  Equilibrium involving a gas phase	Online reading and Questions <b>(SW)</b>  In-class worksheet <b>(SW)</b>  In-class jigsaw <b>(SW)</b>  Homework problems of TD fundamentals <b>(SP)</b>  Online Exam on Thermodynamic Background <b>(SA)</b>
3  <b>Relationship of Thermodynamics to Phase Diagrams &amp; Phase Stability</b>  Weeks (3-5 – 12 lectures)	Difference between phase diagrams and predominance diagrams  Phase diagrams involving temperature and composition  Phase diagrams and other variables – total pressure, chemical potentials, volume, enthalpy, ... for systems of any number of components  Predominance Diagrams & Ellingham Diagrams	Online reading + questions on Phase diagrams <b>(SW)</b>  Online reading + questions on Phase stability <b>(SW)</b>  In-class activities (2) <b>(SW)</b>  Homework on Diagrams and use(2)

	<p>Geometrical rules for phase diagrams</p> <p>Gibbs Energy Curves</p> <p>Fluctuations and instability</p> <p>Metastable phase equilibria and kinetics</p>	<p><b>(SP)</b></p> <p>Online + In-Class exam on Diagrams<b>(SA)</b></p>
<p>4</p> <p><b>Surface, Interfaces &amp; Adsorption</b></p> <p>Week 6 -7( 4 lectures)</p>	<p>Thermodynamics of interfaces</p> <p>Surface effects on heterogeneous phase equilibria</p> <p>Adsorption and segregation</p>	<p>Online reading + questions <b>(SW)</b></p> <p>In-class activities (1) <b>(SW)</b></p> <p>In-class jigsaw<b>(SW)</b></p> <p>Homework on major concepts <b>(SP)</b></p> <p>Online quiz<b>(SA)</b></p>
<p>5</p> <p><b>Developing a vocabulary for corrosion</b></p> <p>Week 8 (3 lectures)</p>	<p>Corrosion and societal costs</p> <p>Electrochemical nature of corrosion</p> <p>Forms of corrosion</p> <p>Corrosion rate determination</p> <p>Corrosion measurement nomenclature</p>	<p>Online reading + questions <b>(SW)</b></p> <p>In-class activities (1) <b>(SW)</b></p> <p>In-class jigsaw<b>(SW)</b></p> <p>Online quiz<b>(SA)</b></p>
<p>6.</p> <p><b>Thermodynamics and Kinetics in relation to corrosion &amp; degradation</b></p> <p>Week 9-10 (5 lectures)</p>	<p>Electrode Potentials</p> <p>Potential/pH – Pourbaix Diagrams</p> <p>Electrochemical Polarization</p> <p>Mixed-Potential Theory</p> <p>Instrumentation and Experimental procedures</p>	<p>Online reading + questions <b>(SW)</b></p> <p>In-class activities (1) <b>(SW)</b></p> <p>In-class jigsaw<b>(SW)</b></p> <p>Homework on major concepts <b>(SP)</b></p> <p>Online quiz <b>(SA)</b></p>
<p>7.</p> <p><b>Passivity and Polarization methods</b></p> <p>Week 10-11 (4 lectures)</p>	<p>Active-Passive Corrosion Behavior</p> <p>Anodic protection and applications</p> <p>Properties of passive films</p> <p>Polarization Resistance Method</p>	<p>Online reading + questions <b>(SW)</b></p> <p>In-class activities (1) <b>(SW)</b></p> <p>In-class jigsaw<b>(SW)</b></p>

	Instrumentation and Experimental procedures	Homework on major concepts <b>(SP)</b>  Online quiz <b>(SA)</b>
8. <b>Remediating/preventing corrosion</b>  Week 12 (3 lectures)	Cathodic Protection  Design and Monitoring  Coatings and Inhibitors  Materials Selection and Design	Online reading + questions <b>(SW)</b>  In-class activities (1) <b>(SW)</b>  In-class jigsaw <b>(SW)</b>  Homework on major concepts <b>(SP)</b>  Online quiz <b>(SA)</b>
9 <b>Case Studies in Corrosion</b>  Week 13+	Galvanic and Concentration cell corrosion  Pitting and crevice corrosion  Environmentally induced cracking  Intergranular, Weldment, and Dealloying corrosion  Corrosion-related damage by Hydrogen, Erosion and Wear  Corrosion in Selected Corrosive environments  Atmospheric & Elevated Temperature Corrosion	Online reading + questions <b>(SW)</b>  Group presentation for case study on corrosion (during exam time 17C) <b>(SP, SA)</b>

16. Attendance and Expectations: Attendance is **strongly** suggested since significant amount of participation, as well as individual and collaborative work will be performed during the class sessions and will be worth as much as 30% of the course points.

**Leaving your cell phone on, leaving early or arriving late** can be VERY distracting, you should avoid it. **All electronic devices (laptops, cell-phones, etc.) should be turned off or in silent mode unless authorized by instructor.**

Use of smartphones, laptops, tablets or similar personal computers is not allowed unless explicitly requested by the individual student the first day of class and for note taking purposes only. No audio/video recording is allowed without express permission of lecturer.

This class will not have a final exam, but will have a group project with a required presentation during the exam time.

This class is a semi-flipped model, and students are expected to do the online readings/videos with questions prior to coming to class. Students may have formative assessments during class to determine understanding of the material.

Students are expected to attend class to participate in the class activities. There is no make up for missed class activities without a doctor's note, or for professional travel or university activities.

17. Grading: Students will be graded according to the following weighted grading:

Student activity work <b>SW</b> (jigsaws, article review, worksheets, online lessons, peer teaching...)	30%
Student Products <b>SP</b> (homework, projects)	40%
Student informal and formal assessments (pre-labs, lab quizzes, surveys, exit tickets, quick writes) <b>SA</b>	30%

18. Grading Scale: Grades will not be curved and there is no extra credit.

Grade Earned percentiles total:

A 93; A- 88; B+ 84; B 80; B- 76; C+ 72; C 68; C- 65; D+ 62; D 59; D- 56; E 50

"A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:

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

19. Make-up Exam Policy : Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found in the online catalog at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

20. Honesty Policy : All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

21. Accommodation for Students with Disabilities : Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

22. UF Counseling Services: Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

23. Software Use: All faculty, staff and student 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 higher standard.

24. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu>.

25. Syllabus Changes – I reserve the right to make changes in the syllabus as needed. Such changes will be announced in class and posted to Canvas e-learning.