MASC 503 – Thermodynamics of Materials
Fall, 2021

Lectures
M/W 3:00 - 4:50 pm
OHE 100D or online (link provided on DEN/Desire2Learn)

Live Class Information
For the Fall 2021 term we will be using the Desire2Learn system for all class activity. All live sessions will be conducted via Webex. This Fall, we will make the live link available to all students in case of any medical and health issues. All students will have access to recorded lectures. On campus students are expected to attend classes in person. DEN@Viterbi students can also attend classes in person if desired but must be compliant to USC’s COVID-19 Vaccination Program. The policy requires vaccination or an approved medical or religious exemption and applies to all USC students, faculty and staff who are accessing the USC campuses and facilities. Please follow all current USC health and safety guidelines: https://we-are.usc.edu/students/. This includes requirements for TrojanCheck each day you visit campus. Please go to https://courses.uscden.net to access Desire2Learn. If you have not used this system before you will need to create a password. Click “Forgot your Password?”. Your username is your full USC email address. To access the Webex live class link, please go to the “Virtual Meetings” item in the course main menu. It is recommended to download and install the WebEx Meetings app for optimal viewing of lectures. Be sure to select your audio and video settings before joining your first meeting. Recordings will be available under My Tools > Panopto Videos and also posted by the DEN team under the corresponding weekly modules. Please review the Panopto player for added interactive elements: https://demo.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=a459ffe4-4937-4328-9d48-bd02d57e53

Course Description
Thermodynamics of Materials is intended for graduate students in Materials Science and Engineering. The goal of the course is to introduce students to a broad treatment of classical and statistical thermodynamics and its applications to equilibrium properties of materials. The course will provide a thermodynamic framework for the treatment of general phenomena in materials science, e.g. chemical reactions, diffusion, and point defects. A focus of the course will be maps of equilibrium states such as phase diagrams. Course topics include the laws of thermodynamics, statistical thermodynamics, solutions, phase equilibria, phase transformations, and phase diagrams of binary and ternary alloys.

Learning Objectives
Students at the end of the course will be equipped with a foundation on classical thermodynamics and statistical thermodynamics that will allow them to:
1. Understand the laws of thermodynamics and their application to mechanical and electromechanical systems, and solutions;
2. Be familiar to both classical and statistical thermodynamics and be able to link macroscopic to microscopic properties;
3. Understand phase equilibrium of single component systems and mixtures;
4. Be able to describe the thermal behavior of solid materials and phase transitions;
5. Be able to read, analyze, and construct phase diagrams.

Instructor
Prof. Paulo Brancio
Mork Family Department of Chemical Engineering and Materials Science
Office: VHE 602
Email: branicio@usc.edu
In person/Online office hours: Wed 5 – 6 pm (email to book a time slot or request another time)

Teaching Assistant
Ms. Emily Gurniak
Office: VHE 609
Email: gurniak@usc.edu
In person/Online office hours: Fri 10 am – 12 pm (book a time slot or request another time by email)

Required Readings and Supplementary Materials
Lecture notes will be provided and contain all required content. The books listed below are reference supplementary readings.
Molecular Thermodynamics, Richard Dickerson, Benjamin, Menlo Park, 1969.

Assessment
The learning outcome will be assessed by three midterm tests, an open book quiz, and a final exam. The midterms and the final test are closed book and closed notes. Midterm tests will be given roughly every four weeks about topics covered in the lectures during each period. The final exam is cumulative and include topics covered in all lectures.

Grading Breakdown

<table>
<thead>
<tr>
<th>Assignment</th>
<th>% of Grade</th>
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<tbody>
<tr>
<td>Midterm 1</td>
<td>20</td>
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<tr>
<td>Midterm 2</td>
<td>20</td>
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<tr>
<td>Midterm 3</td>
<td>20</td>
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<tr>
<td>Quiz</td>
<td>10</td>
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<tr>
<td>Final Exam</td>
<td>30</td>
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### Important Dates
Midterm 1: Monday, September 20th
Midterm 2: Wednesday, October 13th
Midterm 3: Wednesday, November 17th
Quiz: Released on November 10 and due on November 17th
Final exam: Monday, December 13th, 2 - 4 pm

### Attendance
Attendance at in person / synchronous sessions is encouraged, but not required.

### Course Schedule: A Weekly Breakdown

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Readings</th>
<th>Exams</th>
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</table>
| 1    | Thermodynamics Introduction  
First Law of Thermodynamics | Gaskell and Laughlin Ch 1 and 2  
DeHoff Ch 1-2, Ch 3  
Dickerson: Ch 3 |       |
| 2    | First/Second Law of Thermodynamics | Gaskell and Laughlin Ch 2 and 3  
DeHoff Ch 3 and 4  
Dickerson: Ch 3, 4 |       |
| 3    | Second Law of Thermodynamics | Gaskell and Laughlin Ch 3  
DeHoff Ch 3 and 4  
Dickerson: Ch 3, 4 |       |
| 4    | Thermodynamic Relations  
Third Law of Thermodynamics | Gaskell and Laughlin Ch 4 and 6  
DeHoff Ch 3 and 4  
Dickerson: Ch 3, 4 | Mid Term 1 |
| 5    | Statistical Mechanics: Ensembles and  
Thermodynamic Connection | McQuarrie Ch 2 and 3 |       |
| 6    | Statistical Mechanics: Boltzmann,  
Fermi-Dirac, and Bose Einstein Statistics | McQuarrie Ch 4 |       |
| 7    | Statistical Mechanics: Ideal Monatomic and Diatomic Gases | McQuarrie Ch 5 and 6 |       |
| 8    | Statistical Mechanics: Partition Functions and Ideal Polyatomic Gases | McQuarrie Ch 7 and 8 | Mid Term 2 |
| 9    | Phase Equilibria of Single Component Systems | Gaskell and Laughlin Ch 7 and 8  
DeHoff Ch 5 and 7 |       |
| 10   | Thermodynamics of Solutions | Gaskell and Laughlin Ch 9 and 10  
DeHoff Ch 8  
Dickerson: Ch 6 |       |
| 11   | Thermodynamics of Reactions | Gaskell and Laughlin Ch 11 and 12  
DeHoff Ch 11  
Dickerson: Ch 5 |       |
| 12   | Phase Diagrams of Binary Systems | DeHoff Ch 9  
Gordon: Ch 4  
Callister and Rethwisch: Ch 10 |       |
Academic Conduct:
Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” [https://policy.usc.edu/scampus-part-b/]. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on research and scholarship misconduct, [https://policy.usc.edu/research-and-scholarship-misconduct/](https://policy.usc.edu/research-and-scholarship-misconduct/)

Support Systems:
Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. [https://engemannshc.usc.edu/counseling/](https://engemannshc.usc.edu/counseling/)

National Suicide Prevention Lifeline - 1-800-273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. [http://www.suicidepreventionlifeline.org](http://www.suicidepreventionlifeline.org)

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. [https://engemannshc.usc.edu/rsvp/](https://engemannshc.usc.edu/rsvp/)

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: [http://sarc.usc.edu/](http://sarc.usc.edu/)

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. [https://equity.usc.edu](https://equity.usc.edu)

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. [https://studentaffairs.usc.edu/bias-assessment-response-support/](https://studentaffairs.usc.edu/bias-assessment-response-support/)

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. [http://dsp.usc.edu](http://dsp.usc.edu)

Student Support and Advocacy – (213) 821-4710

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<thead>
<tr>
<th>Week</th>
<th>Phase Diagrams of Binary Systems</th>
<th>DeHoff Ch 9 Gordon: Ch 4 Callister and Rethwisch: Ch 10</th>
<th>Mid Term 3 Quiz</th>
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<tr>
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<td>DeHoff Ch 9 Gordon: Ch 4 Callister and Rethwisch: Ch 10</td>
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<td>15</td>
<td>Phase Diagrams of Ternary Systems</td>
<td>DeHoff Ch 10</td>
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<tr>
<td>FINAL</td>
<td>Final Examination</td>
<td>Cumulative</td>
<td>Final</td>
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Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. [https://studentaffairs.usc.edu/ssa/](https://studentaffairs.usc.edu/ssa/)

**Diversity at USC**  
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. [https://diversity.usc.edu](https://diversity.usc.edu)

**USC Emergency Information**  
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. [http://emergency.usc.edu](http://emergency.usc.edu)

**USC Department of Public Safety** – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.  
Provides overall safety to USC community. [http://dps.usc.edu](http://dps.usc.edu)