UNSW Course Outline

MATS2008 Thermodynamics and Phase Equilibria - 2024

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General Course Information

Course Code : MATS2008
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Materials Science & Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course will provide students with an understanding of thermodynamic functions and properties of materials (chemical, mechanical and physical). The course will introduce the laws of thermodynamics and their application, with an emphasis on thermodynamics of materials

formation and transformation, as well as the fundamentals of chemical equilibrium and gas-solid equilibria. Specific topics and techniques covered include Ellingham diagrams; electrochemistry: Pourbaix diagrams; thermodynamics of solutions; Raoult's and Henry's Law, fugacity and activity, the Clausius Clapeyron Equation; and the construction and interpretation of 2 component phase diagrams and phase rules.

The course will be delivered through lectures and laboratory activities and is designed for students in the second year of their materials science and engineering degrees.

Course Aims

The aim of this course is to introduce basic thermodynamic principles and how these principles can be applied to understand phase transitions and the chemical and electrochemical processes of pure substances, solutions, and multiphase systems. The course will also introduce the principles of binary phase diagrams and how they can be applied to interpret and predict conditions of processing and performance. These principles and techniques are critical for understanding materials formation and processing. The course content provides fundamental knowledge for the future learning in materials science.

Relationship to Other Courses

First 6 weeks of this course will be jointly conducted with MATS6101

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Identify and relate basic thermodynamic concepts in the context of materials engineering.
CLO2 : Apply basic concepts of thermodynamics to describe and predict the behaviour of materials in the gas, liquid, and solid phase.
CLO3 : Solve problems involving the thermodynamic parameters related to liquid- gas-solid phase equilibria.
CLO4 : Calculate the parameters to generate phase diagrams.
CLO5 : Interpret phase diagrams to determine materials processing parameters and predict the performance of various materials.

Course Learning Outcomes	Assessment Item
CLO1 : Identify and relate basic thermodynamic concepts in the context of materials engineering.	• Quizzes • Assignment • Laboratory Reports
CLO2 : Apply basic concepts of thermodynamics to describe and predict the behaviour of materials in the gas, liquid, and solid phase.	• Laboratory Reports
CLO3 : Solve problems involving the thermodynamic parameters related to liquid- gas-solid phase equilibria.	• Quizzes • Assignment
CLO4 : Calculate the parameters to generate phase diagrams.	• Final Exam • Assignment
CLO5 : Interpret phase diagrams to determine materials processing parameters and predict the performance of various materials.	• Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Blackboard Collaborate | Echo 360

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Quizzes Assessment Format: Individual	40%	Start Date: Week 3 & Week 7 Due Date: Not Applicable
Assignment Assessment Format: Individual	15%	Start Date: Week 5 Due Date: Week 7: 08 July - 14 July
Laboratory Reports Assessment Format: Individual	15%	Start Date: TBA Due Date: TBA
Final Exam Assessment Format: Individual	30%	Start Date: Exam Period Due Date: Not Applicable

Assessment Details

Quizzes

Assessment Overview

You will complete two quizzes of 2 hours in duration. The quizzes will cover

(1) fundamentals of thermodynamics (week 3, worth 15%)

(2) solution thermodynamics and phase diagram construction (week 7, worth 25%)

Feedback: You will receive your marked quiz after the quiz has closed. Further worked solutions and overall comments may also be provided to the class.

Hurdle requirement: In order to pass the course, you must achieve:

1) 40% on the final exam, and

2) 40% average between Quiz 1 and Quiz 2

Course Learning Outcomes

- CLO1 : Identify and relate basic thermodynamic concepts in the context of materials engineering.
- CLO3 : Solve problems involving the thermodynamic parameters related to liquid- gas-solid phase equilibria.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

Satisfactory completion of the course includes the requirement to achieve ≥35% in the Quizes and ≥35% in the final exam, and ≥45% weighted average over the two exams. Students who fail

to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of if they receive over 50% in total for the course.

Assignment

Assessment Overview

You will be required to complete a problem-based assignment in the areas of equilibrium and gas-solid phase transitions. The assignment will be posted on Moodle in week 5 and is due in week 7. Submissions after deadline will not be assessed.

Feedback: You will receive solutions to the assignment and feedback on your performance for each question. Additional feedback is available from the convenor on request.

Course Learning Outcomes

- CLO1 : Identify and relate basic thermodynamic concepts in the context of materials engineering.
- CLO3 : Solve problems involving the thermodynamic parameters related to liquid- gas-solid phase equilibria.
- CLO4 : Calculate the parameters to generate phase diagrams.

Assignment submission Turnitin type

Not Applicable

Laboratory Reports

Assessment Overview

You will undertake two laboratory experiments over two lab sessions. These will illustrate the principles of:
(1) enthalpy of solution by calorimetry
(2) enthalpy of solution by variation of solubility with temperature.

For each experiment you will submit a report based on a set of provided questions, to be submitted at the end of the laboratory class. Each report is worth 7.5% of the course total mark.

You will be divided into groups for the laboratory sessions, but you will be assessed individually. There will be a mandatory induction in Week 1 for all students. A roster of the laboratory work will be posted online, which will outline when the experiments are scheduled for each group

Feedback: You will receive your marked report with individualised feedback. Feedback for the first report will be provided by the second lab for you to review in preparing your second report.

Feedback for the second report will be delivered two weeks after submission.

Course Learning Outcomes

- CLO1 : Identify and relate basic thermodynamic concepts in the context of materials engineering.
- CLO2 : Apply basic concepts of thermodynamics to describe and predict the behaviour of materials in the gas, liquid, and solid phase.

Final Exam

Assessment Overview

The final examination will be 2 hours in duration and will be held during the official examination period. The exam will include multiple choice and problem-based questions related to the interpretation and application of binary phase diagrams.

Feedback: You will receive your exam mark with your final course mark. Further feedback is available by inquiry with the course convenor.

Hurdle requirement: In order to pass the course, you must achieve:
1) 40% on the final exam, and
2) 40% average between Quiz 1 and Quiz 2

Course Learning Outcomes

- CLO4 : Calculate the parameters to generate phase diagrams.
- CLO5 : Interpret phase diagrams to determine materials processing parameters and predict the performance of various materials.

Assignment submission Turnitin type

Not Applicable

Hurdle rules

Satisfactory completion of the course includes the requirement to achieve ≥35% in the Quizes and ≥35% in the final exam, and ≥45% weighted average over the two exams. Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of if they receive over 50% in total for the course.

General Assessment Information

Grading Basis

Standard

Requirements to pass course

Satisfactory completion of the course includes the requirement to achieve ≥35% in the Quizes and ≥35% in the final exam, and ≥45% weighted average over the two exams. Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of if they receive over 50% in total for the course.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Language of thermodynamics. State functions. Heat and work. Internal energy, enthalpy, and entropy changes in chemical and physical processes.
	Laboratory	Laboratory induction - lab streams 1 and 2.
Week 2 : 3 June - 9 June	Lecture	Gibbs and Helmholtz energies. Chemical Equilibrium. Redox processes. Thermodynamics of redox processes. Pourbaix diagrams
	Laboratory	Enthalpy of solution by calorimetry (CL1) - lab stream 1
Week 3 : 10 June - 16 June	Assessment	Quiz 1
	Lecture	Joshi's lecture starts: Equilibrium, Reaction Quotient and Rate Laws
Week 4 : 17 June - 23 June	Lecture	Thermodynamic Properties of Pure Fluids, Enthalpy, Heat Capacity, Entropy & Properties Classification
	Laboratory	Enthalpy of solution by calorimetry (CL1) - lab stream 2
Week 5 : 24 June - 30 June	Assessment	Assignment (15%) Questions will be uploaded on Moodle
	Lecture	Understanding and Application of the Clausius-Clapeyron Equation, and Fugacity
	Laboratory	Enthalpy of solution by solubility (T1) - lab stream 1
Week 7 : 8 July - 14 July	Lecture	Colligative Properties, Osmosis and Diffusion, Raoult's Law and Henry's Law Ellingham Diagram, Phase Rule, and Intrucution to phase diagram
	Assessment	Quiz 2 (25%)- Joshi
Week 8 : 15 July - 21 July	Lecture	Lecture 1: Microstructures, diffusion, Hume-Rothery's rules, point defects Lecture 2: Line, plane, volume, electronic, and other defects Lecture 3: Crystal imperfections, diffusion mechanisms, interfaces, grain boundaries Lecture 4: Crystalline solids, defect structures, Kröger-Vink notation, intrinsic and extrinsic defects
Week 9 : 22 July - 28 July	Lecture	Week 9 Lecture 5: Intrinsic and extrinsic defect reactions, solid solubility and charge compensation mechanisms Lecture 6: Intrinsic and extrinsic defect equilibria, example exam question 1 Lecture 7: Example exam questions 2 and 3 Lecture 8 : Review Lecture 9 : (Optional) Worked final exam from 2021

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

https://timetable.unsw.edu.au/2024/MATS2008.html

Course Resources

Recommended Resources

All the lecture notes and course materials will be on Moodle.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Rakesh Joshi		Hilmer 448	0449534314	Messaging on Teams OR by appointment	No	Yes
Lecturer	Ron Haines		Room 128, Dalton Building		By appointment	No	No
	Charles Sorrell				By appointment	No	No

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://

student.unsw.edu.au/special-consideration

Important note: UNSW has a “fit to sit/submit” rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines