

## MONTANA TECH

### Metallurgical & Materials Engineering Department

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#### EMAT 307 – Metallurgical & Materials Engineering Thermodynamics

#### Syllabus

**Instructor:** Dr. Jerry Downey (ELC 215; 496-4578)

**Office hours:** as posted

**Course Description:** Fundamental thermodynamic principles are introduced and the application of thermodynamics and physical chemistry to metallurgical and environmental processes is illustrated. Industrial examples are presented.

**Credits and Class Meetings:** The 3 credit-hour (lecture) course is scheduled to meet in in ELC 327 from 11:00 to 12:15, Tuesdays and Thursdays.

**Designation:** required for the Bachelor of Science degree in Metallurgical and Materials Engineering.

**Prerequisites:** CHMY 143 or consent of instructor.

**Textbook and References:** No textbook is required.

Supplemental reading may be assigned in class. Course information and thermodynamic data for the problem sets will be drawn from multiple references, which include:

1. Metallurgical Thermochemistry (Fifth Edition), O. Kubaschewski and C.B. Alcock, Pergamon Press, 1979, 449 pages (ISBN 0-08-020897-5 and 0-08-022107-6)
2. Thermodynamic Data for Mineral Technology, L.B. Pankratz, et al, USBM Bulletin 677, 1984, 355 pages
3. Thermodynamic Properties of Elements and Oxides, L.B. Pankratz, USBM Bull.672, 1982, 509 pages

**Topics:** the planned lecture topics include:

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| 1. Course overview                      | 10. Ellingham and predominance area diagrams                                       |
| 2. Introduction and definition of terms | 11. Unary and multicomponent phase diagrams  |
| 3. First law of thermodynamics          | 12. Application of thermodynamic principles to metallurgical and materials systems |
| 4. Heat capacity and enthalpy           | a. Thermal processes   |
| 5. Thermophysics and thermochemistry    | b. Aqueous processes   |
| 6. Second and third laws                | c. Electrolytic processes  |
| 7. Gibbs free energy                    |  |
| 8. Gas behavior                         |  |
| 9. Solution behavior                    |  |

**Objectives and Outcomes:** The course focuses on the application of chemical thermodynamics to metallurgical and materials engineering problems. Following presentation and review of the fundamental thermodynamic principles, the course emphasizes problem solving relative to applications that involve thermal, aqueous, and/or electrolytic systems.

The course is designed to acquaint students with the fundamentals of chemical thermodynamics and enable them to become proficient in performing thermodynamic calculations that include determination of process heat requirements (excess or deficit), heat balances, reaction feasibility, and equilibrium yield. Students will also learn how to construct phase stability diagrams for condensed systems. Industrial examples are selected to illustrate how the theory is applied to practical engineering problems and decision making.

The course objectives and outcome are responsive to the following ABET Criteria for skills, knowledge, and behaviors:

- (1) Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- (6) Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions

## Evaluation and Grading Criteria:

**Attendance** is a factor in the determination of course grades. Students are permitted three (3) absences without penalty. Thereafter, 1% will be subtracted from the student's final weighted average for each additional absence.

Students are responsible for notifying the instructor and sitting for quizzes in advance of field trips, athletics, or other school-sanctioned events that force them to miss class. If the event forces the student to miss a scheduled examination, a make-up examination will be scheduled.

Regardless of the reason for absence, students are responsible for all material covered or assigned in class, including reading assignments. Students should arrange to obtain class notes from another student. Do not ask to borrow the instructor's lecture notes or grading keys.

**Examinations** include a mid-term and a final examination. Unless otherwise specified by the instructor, the examinations are strictly closed book and closed notes. The mid-term examination is tentatively scheduled to take place in mid-March (prior to Spring Break), and the final examination will take place at the time and date designated by the Registrar's Office at the start of the semester – no exceptions.

It is the student's responsibility to sit for the examinations at the scheduled dates and times. A missed examination is assigned the grade of zero (0). Under exceptional circumstances, a student may be permitted to sit for a make-up exam, which is guaranteed to be more difficult than the scheduled exam that it replaces. The student is required to submit a written request for the make-up examination to the instructor within one week following the missed examination.

**Quizzes** are generally intended to reinforce the learning process and may be given with or without advance notice (i.e. a "pop quiz"). Subject matter covered during previous and present lectures and/or the associated readings is considered fair game. Quizzes are typically scheduled for the last 15 minutes of class on Thursdays. The pop quiz frequency correlates directly to the occurrence of classroom disruptions during lecture. Disruptions include but are not necessarily limited to late arrivals or early departures by students, extraneous conversations, cell phone usage, etc. Each quiz question is graded on a 100-point basis and there is no limit to the number of quizzes that may be given during the semester. Make-up quizzes are not given in instances of unexcused absence.

**Notebook** must be submitted for grading on Tuesday, April 24. Students are expected to organize their lecture notes, supplemental reading and reference materials, practice problems, graded quizzes and examinations, and other course materials in a three-ring binder. The notebooks are graded on a 100-point basis with 91-100 points for excellent, 81-90 points for good, 71-80 points for average, 61-70 points for poor. Notebooks that are incomplete and/or exhibit minimal effort receive scores of less than 60 and notebooks not submitted are assigned a score of zero.

**Homework** is not a factor in course grade determinations. No homework will be assigned, collected or graded. The instructor will post a series of problem sets that relate to the lectures. Students are advised to master the solutions to these problems in preparation for quizzes and the two examinations.

**Course grades** are determined according to the following formula:

Quiz average:	15%
Mid-term examination:	40%
Final examination:	40%
Notebook:	5%
Attendance adjustment	1% deducted for each unexcused absence (after the 3 <sup>rd</sup> one)

where the total will determine the student's final grade according to the following scale:

- A = > 90%
- B = > 80% to 90%
- C = > 70% to 80%
- D = > 60% to 70%
- F = ≤ 60%

Plus and minus grades may be assigned at the instructor's discretion.

Each student receives feedback on his or her current class standing when graded examinations and quizzes are returned. The feedback includes the student's exam or quiz score, the class average for the exam or quiz, the student's current cumulative average, and the student's current grade.

### **Grading rubrics:**

Unless otherwise specified by the course instructor, each quiz and examination will be graded on the basis of 100 points (maximum). The general grading guidelines are:

- A serious attempt by the student receives a minimum score of 50% (bear in mind that 50% is not a passing score in this course). Problem solutions that involve computations and/or derivations must clearly indicate all significant steps, state assumptions, express answers with proper units, and clearly indicate the final answer.
- Correct procedure: 50 to 75% -- the student must demonstrate an understanding of the principles covered by the problem and employ an appropriate solution strategy.
- Proper solution mechanics: 75 to 95%; 5 points will be deducted for each mathematical error, incorrect or omitted solution step, and erroneous assumption.
- Correct answer and units: 95 to 100%; points will be deducted for incorrect or imprecise answers and for incorrect or omitted units.

When multiple choice problems appear on quizzes and examinations, the student receives full credit for a correct selection and zero for an incorrect selection. If the student believes that the correct answer does not appear in the list of options (a, b, c, or d), the student may challenge the question by writing the word "challenge" in the margin to the left of the options and then providing the correct solution in the space to the right of the options. If the challenge is correct, the student will be awarded double points for that particular problem. There is no penalty for an incorrect challenge; students are advised to circle the letter that precedes the answer that they believe is most accurate of the choices provided. In considering this option, realize that numerical options may be rounded (e.g., 36.0 kilojoules rather than 35,951 joules). Frivolous challenges will be disregarded.

**Academic Integrity:** Students enrolled in the Metallurgical and Materials Engineering courses are expected to maintain an integrity standard that is consistent with the applicable fundamental canons of the NSPE Code of Ethics for Engineers. Specifically, students are expected to conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Academic dishonesty or cheating will not be tolerated. Students are expected to adhere to the Montana Tech Academic Honesty policy (see Addendum 1 and/or the Montana Tech student handbook).

If it is determined that a student has deliberately cheated on a report, quiz, or examination, the student will be dropped from the course with an "F" grade. In compliance with Montana Tech policy, all cases of academic dishonesty will be reported to the Office of the Vice Chancellor for Academic Affairs.

With one exception, the Department policy is that electronic devices are not to be activated or evident during lectures, quizzes, and examinations. This restriction includes but is not limited to programmable calculators, cell phones, laptop computers, mp3 players, dvd players, and all types of recording devices. The exception is that students are permitted to use a nonprogrammable calculator during lectures, quizzes, and exams. Students that possess unapproved calculators or other electronic devices during a quiz or exam are subject to dismissal from the classroom.

No student is allowed to record, tape, or photograph any classroom or laboratory activity without the express written consent of the instructor.

**Disability Accommodations:** Students that need academic accommodation because of disabilities must:

1. Register with and provide documentation to the Montana Tech Student Disability Coordinator
2. Provide the instructor with a letter that states the need and type of accommodation. This should be done during the first week of class.

In case that a student believes that he/she needs to record or tape classroom activities due to disability, the student must request an appropriate accommodation. In the event that such an accommodation has been arranged, the material may not be further copied, distributed, published, or otherwise used for any other purpose without the express written consent of the instructor.

**Professional Component:**

Engineering Topics:	100%
Design Component:	Yes (application of thermodynamic principles to design of experiments and development of fundamental process design criteria)
Computer Usage:	No
Ethics:	Yes (importance of thermodynamic evaluations to due diligence)
Statistics:	No
Safety:	No

**Prepared by:**

J. P. Downey

Finalized:

## **ADDENDUM 1: Montana Tech Academic Honesty Policy**

Montana Tech believes that academic honesty and integrity are fundamental to higher education. Montana Tech has a responsibility to promote academic honesty, integrity, and the highest ethical and professional standards and behavior in and out of the classroom. Accordingly, policies and procedures have been developed to address instances of academic dishonesty. Students who violate these standards commit academic misconduct and will be subject to academic and/or disciplinary sanctions.

### **Academic Dishonesty**

Academic dishonesty includes cheating; plagiarism; forgery; falsification; facilitation or aiding academic dishonesty; multiple submission; theft of instructional materials or tests; access to, manipulation of, or tampering with laboratory equipment, experiments, or computer programs without proper authorization; alteration of grades or files; misuse of research data in reporting results; use of personal relationships to gain grades or favors; and any actions intended to gain academic advantage by fraudulent and/or deceptive means.

### **Student Responsibility**

The student has full responsibility for the content and integrity of all academic work submitted. Ignorance of a rule does not constitute a basis for waiving the rule or the consequences of that rule. Students unclear about a specific situation should ask their instructors or academic staff, who will explain what is and is not acceptable in their classes or on campus.

### **Faculty, Staff, and Administrator Responsibility**

It is the shared responsibility of faculty, staff, and administrators to take reasonable precautions to prevent and discourage academic dishonesty. Additionally, it is a duty of faculty, staff, and administrators to report instances and charges of academic dishonesty to the Office of the Vice Chancellor for Academic Affairs through the Academic Dishonesty Violation online referral form.

### **Cheating**

Cheating is defined as obtaining or attempting to obtain, or aiding another in obtaining or attempting to obtain credit for work or any improvement in evaluation of performance by any dishonest or deceptive means. Cheating includes, but is not limited to, the following.

#### **Taking information:**

1. Copying graded homework assignments from another student.
2. Working with others on a take-home test or homework (unless specifically accepted by the instructor).
3. Looking at another student's paper or screen during an examination.
4. Looking at text, notes, or electronic devices (e.g., cell phones, tablets, smart pens, unauthorized calculators, etc.) during an examination (unless specifically accepted by the instructor).
5. Accessing another student's electronic device (e.g., cell phone, tablet, laptop, desktop, etc.) and taking information from the device without consent.
6. Allowing another person to complete assignments or an on-line course.

#### **Providing information:**

1. Giving one's work to another to be copied or used in an oral presentation.
2. Giving answers to another student during an examination or for a take-home test.
3. Informing a person in a later section about questions appearing on an exam after taking that exam.
4. Providing a term paper to another student
5. Taking an exam, writing a paper, or creating a computer program for another student.

### **Plagiarism**

Plagiarism is defined as submitting a term paper, essay, speech, laboratory report, or other assignment in which all or part of the words, ideas, or visuals are copied from the published or unpublished work of another individual without giving the original author proper credit for the words, ideas, or visuals. Such actions include, but are not limited to, the following.

1. Copying homework answers from a text to hand in for a grade.
2. Failing to give credit for ideas, statements, data, or conclusions derived by another author.
3. Failing to adequately summarize or paraphrase another's work.
4. Failing to use quotation marks when quoting directly from another, whether it be a paragraph, a sentence, or a part thereof.
5. Submitting a paper purchased from a research or term paper service or downloaded from the internet.
6. Copying another student's or a former student's paper and handing it in as one's own.
7. Giving a speech or oral presentation written by another and claiming it as one's own work.
8. Presenting another's computer program as one's own.
9. Failing to acknowledge the source of copied or adapted visuals.

### **Other Forms of Academic Dishonesty**

Other forms of academic dishonesty include any actions intended to gain academic advantage by fraudulent and/or deceptive means not addressed specifically in the definition of cheating and/or plagiarism. These actions may include, but are not limited to, the following.

1. Planning with one or more fellow students to commit any form of academic dishonesty together.
2. Giving a term paper, speech, or project to another student when one knows or reasonably suspects that student will plagiarize it.
3. Having another student take one's exam, or complete one's computer program or lab experiment.
4. Lying to an instructor to increase a grade or gain additional time to complete an assignment or exam.
5. Submitting substantially the same paper or speech for credit in two different courses without prior approval of the instructors involved.
6. Altering a graded work after it has been returned, then submitting the work for regrading, without the instructor's prior approval.
7. Removing tests from a classroom without the approval of the instructor, or stealing tests.
8. Using a person's signature without permission.
9. Offering, giving, receiving, or soliciting a bribe of money, materials, goods, services, or anything of value for the purpose of procuring or providing an academic advantage.
10. Forging documents or other data, or omitting facts which are material to the purpose for which the information is submitted to the University, potential employers, or community members.
11. Possession of unauthorized equipment or materials during a test, quiz, or similar, whether found accessing or not.

### **Policy on Cheating, Plagiarism, and Other Forms of Academic Dishonesty**

At faculty discretion, cheating may result in an F grade on the assignment or examination, or in the course. If a student does not accept the charge of cheating, s/he may bring the case to the Academic Standards Committee for review. Plagiarism may be considered a form of cheating and is, therefore, subject to the same consequences as cheating. However, as there may be plagiarism as a result of poor learning or inattention to format, and there may be no intent to deceive, some instructor discretion is appropriate. Under such circumstances, the instructor may elect to work with the student to correct the problem at an informal level. In any case that a penalty is applied, the student must be informed of the event being penalized and of the penalty.

The instructor shall contact the student with evidence of the academic dishonesty incident in writing within 10 business days of discovery of the event. The Academic Dishonesty Violation Referral form will also be submitted electronically to the Office of the Vice Chancellor for Academic Affairs. The instructor will show the student all evidence being considered and allow the student to fully respond. The instructor will notify the Vice Chancellor for Academic Affairs of the intended disciplinary action.

The Office of the Vice Chancellor for Academic Affairs shall determine if any further disciplinary action is required. In reported cases of repeated academic dishonesty, the Academic Standards Committee may be alerted and may apply additional penalties beyond those imposed by the individual instructors. Disciplinary actions might include, but are not limited to, reprimand; educational sanctions (completion of a report, paper, project, or workshop); loss of membership in organizations; or disciplinary probation, suspension, or expulsion from the University. If the Office of the Vice Chancellor for Academic Affairs and/or the Academic Standards Committee determines that no violation has occurred, the instructor will comply with the decision, and refrain from issuing penalties, or remove those already on the student's record.