MONTANA TECH
Department of Metallurgical & Materials Engineering

EMET 2320
Processing of Particulate Systems
Lecture: TR 9:30-10:45a.m.
Room: ELC 202

Instructor: Dr. C.A. Young
Office Hours, ELC 208A, Spring
1:00-2:00p.m., TR or by appointment

2010-11 Catalog Description:
An introduction to processing methods and equipment, particularly those utilized in the mining industry. Topics include material balances, size analysis, crushing, grinding, classification, flotation, leaching, magnetic, gravity and electrostatic separations. Applications to recycling and aggregate/concrete industries are discussed. A major design problem is given to cover process design and material balances.

Credits: 2 Credit-Hours (Lecture)

Designation: Required (Metallurgical and Materials Engineering; Mining Engineering; Mining/Geology Option in Geological Engineering)

Prerequisite: Instructor Approval

Lab: Arranged with MetE 2340 (Co-Requisite). This 'hands-on' experience is provided without which the lecture material cannot be completely understood.


References: John M. Currie, Unit Operations in Mineral Processing, U of British Columbia

Relationship of Course to Metallurgical & Materials Engineering Program Outcomes: Course further introduces students to process engineering and design helping to develop concepts of unit operations and further knowledge in flowsheet design and material balances as well their interactive dependence on particle size, sampling, analysis and economics.

Objectives: The course is designed to introduce and describe the art, science and engineering of mineral processing to students. The goals are simple: gain a fundamental understanding of processing particularly those applied to primary production. To do this, the topics listed on the next page are discussed in detail in close conjunction with labs conducted in a separate course. Laboratory exercises require that the student develop an understanding of some fundamental operations and proficiency in carrying out such test work.

Outcomes: Graduates of this course will or will be able to:
1. Understand the reasons for using comminution, sizing, separation and dewatering processes, particularly in the mineral and cement/aggregate industries.
2. Conduct mass balance calculations and apply them to simple and complex flowsheets.
3. Gain an appreciation for sampling and analysis and understand that its statistical significance is critical to mass balancing, metallurgical performance and economics.
4. Describe the basic unit operations in modern day mineral processing.
5. Evaluate unit operations for use in other potential applications such as secondary production (i.e., recycling).
6. Gain an appreciation for flowsheets and their design.
7. Be prepared for success in MetE 2330 and other subsequent process metallurgy courses.
8. Meet ABET Outcome k (see below)
9. Initiate Program Specific Outcome m (see below)

**Topics:** Most topics are illustrated through laboratory experiments:

1. Lab Orientation & Safety (See MetE 2340 Laboratory Exercises)
2. Process Engineering - Definition and Scope (1 class)
   a. Minerals – Density and Content
   b. Properties – Principles of Separations
   c. Example Flowsheets (Montana Tunnels and Golden Sunlight)
3. Introduction to Material Balances (4 classes)
   a. Sampling and Analysis
   b. Mass In/Out and Steady State
   c. Smelter Schedules
   d. Metallurgical Performance
4. Particle Shape & Size Analysis (1 class)
5. Separation Methods and Unit Operations (15 classes)
   a. Gravity – Table, Knelson, Jig, HMS, Spiral
   b. Electrostatic – High Tension, Eddy Current
   c. Magnetic – permanent, electromagnet, RE
   d. Flotation – collector, frother, activator, depressant, pH modifier
   e. Chemical – leaching, adsorption, IX, SX, EW, cementation, precipitation
6. Sedimentation and Dewatering Methods (2 classes)
   a. Thickening – Conventional, Lamella, High Rate, Tray
   b. Filtering – Drum, Plate-n-Frame
   c. Drying – Rotary and Calcining Comparison
7. Sizing and Circulating Loads (2 classes)
   a. Classifiers – Rakes, Spirals, Belts, Hydrocyclones
   b. Screens – Shaking, Vibratory, Gyrotary, Oscillatory
8. Comminution/Size Reduction (3 classes)
   a. Blasting – Mentioned Only
   b. Crushing – Jaw, Gyrotary, Roll
   c. Grinding – AG, SAG, Rod, Ball
   d. Energy – Consumption and Bond Work Index
9. Flowsheets, Plant Safety and Health Considerations (2 classes)

**Homeworks:** Homeworks are required periodically and are normally due one week after they are given. The last homework will include a major design problem regarding process flows and mass balances.

**Quizzes:** Generally intended to reinforce the learning process, quizzes may be given with or without (i.e. a “pop quiz”) advance notice. Subject matter covered during the previous and present lecture and/or the associated readings is considered fair game.
Examinations: There will be three to four 1-hour examinations. The last test will not be a final; however, you are expected to know previous material.

Attendance: Roll is taken periodically and counted as approximately 10% of your grade. Excessive absence will result in lowering of the final grade. There will be no class the week of Feb 28-March 4. The course lectures will conclude approximately April 14.

Grading: The final grade will be weighted from the above course elements approximately as follows:

- Assignments/Quizzes: 15%
- Examinations: 75%
- Attendance: 10%

Disruptions: The pop quiz frequency correlates directly to the occurrence of classroom disruptions during lecture. Potential disruptions include but are not necessarily limited to: late arrivals or early departures by students, extraneous conversations, cell phone usage, text messaging, use of extraneous electronic devices (see below), etc. Each quiz question is graded on a 10-point basis and there is no limit to the number of quizzes that may be given during the semester.

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. Acts of academic dishonesty include (but are not limited to):

- Plagiarism including on homework assignments and lab reports
- Copying from another student’s paper while taking a quiz or examination
- Using unlawful aids (books, notes, cell phones or other electronic devices, etc.) to pass an examination (unless the instructor has clearly stated that it is an open notes or open book exam)
- Assisting another student in an act of academic dishonesty

If it is determined that a student has deliberately cheated on a quiz, examination, or assignment, he or she will be dropped from the course with an “F” grade. In compliance with Montana Tech policy, cases of academic dishonesty will also 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 and examinations. This restriction includes but is not limited to programmable calculators, cell phones, I-pods, or entertainment devices. The exception is that students are permitted to use a calculator from the following list during lectures, quizzes, and exams:
Casio – any model fx-115 calculator
Hewlett-Packard – the HP33s and 35s models
Texas Instruments – all TI-30X or TI-36X models

Students that possess unapproved calculators or other electronic devices during a quiz or exam are subject to dismissal from the classroom. Penalties for disregarding the policy during lecture will be enforced at the instructor’s discretion.

Professional Component:
- Engineering Topics – 100%
- Engineering Design – Yes
- Computer Usage – spreadsheets (limited)
- Ethics – Yes (some - environmental)
- Statistics – Yes (some)
- Safety – Yes (industrial and laboratory)

ABET Outcomes Covered: k and m
- use the techniques, skills and modern engineering tools necessary for engineering practice.
- have an integrated understanding of the scientific and engineering principles underlying the major elements of the field which include structure, properties, processing, and performance related to metallurgical and material systems,

Prepared by: C.A. Young

Date: January 8, 2011