# MONTANA TECH

## Department of Metallurgical & Materials Engineering

## EMET 233 – Design of Particulate Systems

**Instructor:** Dr. A. Das
**Office Hours:** ELC 213, MWF 9:00-10:00 or by appointment, Fall Semester
**Lecture:** ELC 327; TR 9:30-10:45
**Prerequisites:** EMET 232 or Consent of Instructor
**Co-Requisite:** EMET 235 Lab with A. Das
**Designation:** Required in M&ME

**2012-13 Catalog Description:**
Size reduction processes of crushing and grinding, particle sizing methods of screening and classifying, and solid/liquid separations of thickening and filtering are detailed. Types of equipment, methods for sizing equipment, prediction of energy requirements, flowsheet development, and safety considerations are examined.

**Credits:** 2 Credit-Hours (Lecture)

**Lab:** Students must register for EMET 235 (Co-requisite). This 'hands-on' experience is provided without which the lecture material cannot be completely understood.

**Textbook:** B.A. Wills, *Mineral Processing Technology*, 7th Edition, Pergamon Press, Oxford, 1984. Handouts from notes and references will be provided as and when needed.

**References:**
1. A. L. Mular and G. V. Jergensen III, Editors, Design and Installation of Comminution Circuits, Society of Mining of AIME, New York, 1982.
2. A.L. Mular, D.N. Halbe, and D.J. Barratt, Editors, Mineral Processing Plant Design, Practice, and Control, SMExploration, Inc., Littleton, CO, 2002.
3. Kelly and Spottiswood, *Introduction to Mineral Processing*, John Wiley & Sons, N.Y, 1982.

**Relationship of Course to Metallurgical & Materials Engineering Program Outcomes:**
The course is intended to build on the foundation established in EMET 232 and thereby further the students' knowledge of unit operations and flowsheet design but additionally follows procedures and calculations to design and size thickeners, screens, crushers, grinding mills, and hydrocyclones. In this regard, the course serves as the first major course in M&ME for the design experience.

**Objectives:**
Because this course is the students' first major exposure to the design experience, it provides students with an understanding and capability of determining type and size of equipment from basic measurements and, in this regard, the student also acquires the capability of specifying and evaluating equipment and performance. 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 and describe separation processes and unit operations not covered in EMET 232
2. Conduct calculations to size equipment (crushers, screens, thickeners, grinding mills and hydrocyclones)
3. Gain further appreciation for spreadsheet calculations and flowsheet design
4. Succeed in subsequent process metallurgy courses

5. Meet **ABET Outcomes** 1, 2, 5, 7, 9, and 10 (consult the Course Catalog and Department Guidelines)

**Topics:**

1. Lab orientation & safety (See EMET 235 Laboratory Exercises)
2. Review of size distribution
3. Industrial screening - screen types, efficiency, design, selection and sizing
4. Particle fracture, breakage & selection functions
5. Energy laws of comminution
6. Crusher types, principles, definitions and descriptions, design and selection
7. Crushing circuits and gradation curves
8. Grinding mill types, principle and operation, mill design, selection and circuits
9. Movement of solids in fluids
10. Hydrocyclone principle, operation and partition
11. Hydrocyclone design and sizing
12. Other classifier design and selection
13. Sedimentation and thickener design
14. Flocculation and coagulation
15. Conventional and enhanced gravity concentration
16. Gravity circuit design
17. Magnetic separation
18. High tension separation
19. Triboelectric separation
20. Agglomeration – briquetting, palletization and sintering

**Homeworks:** Homeworks/assignments will be individual or team efforts and will include developing spreadsheets to calculate equipment sizes and perform mass balances. No homework will be accepted after the deadline.

**Computer Usage:** Spreadsheet development of simple and complex design problems including mass balances are required.

**Attendance Policy:** Roll is taken periodically and may not count towards final grade normally. However, marked absence will evoke new policy and may adversely affect the final grade.

**Examinations:** This course has one mid-term test, quizzes and a design project with no final exam; however, if attendance is poor or, as discussed below, classes are disrupted or academic integrity is ignored, the scheduled final exam will be required along with additional tests and quizzes as needed.

**Design Project:** Students will design a flowsheet and then calculate mass-balances and size each unit operation in it. This is considered to be the Take-Home Final unless an actual final becomes warranted.

**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. If given, each quiz question will be graded on a 10-point basis and there is no limit to the number 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 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 who 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.

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

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| Homework Assignments | 20% |
| Quizzes | 20% |
| Project | 40% |
| Midterm | 20% |

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

**ABET Outcomes Covered:** 1, 2, 5, 7, 9 and 10

1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
7. acquire and apply new knowledge as needed, using appropriate learning strategies
9. integrate the understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing and performance related to metallurgical and materials systems appropriate to the field, and
10. apply and integrate knowledge from each of the above four elements of the field using experimental, computational and statistical methods to solve materials problems including selection and design consistent with the program educational objectives.

**Prepared by:** Avimanyu Das **Date:** November 12, 2018