EMAT 471 (MME 4710) Instructor: Dr. Sudhakar K.V.  
Materials Characterization & Analysis  
Lecture: Tu, R 2:00–2:50 pm, ELC 203  
Office: ELC 218, x 4267  
Office Hours: M through F, 11:00-12:00 noon or by appointment

**2010-2011 Catalogue Description:**
This course emphasizes analytical techniques commonly used by metallurgical/materials engineers. The techniques will include: x-ray diffraction, XRF, scanning electron microscopy/energy dispersive x-ray emission/mineral liberation, induction coupled plasma spectrophotometry and other aqueous analytical techniques (*depending on available time*)-particle size analyses, Gas/Ion chromatograph, carbon/sulfur analyses, specific ion electrodes, etc).

**Credits:** 3.00 Credit Hours (Two credits of lecture, One credit of laboratory demos/experiments)

**Designation:** Required course (Metallurgical & Materials Engineering)

**Prerequisites:** Graduate or Senior Standing or Consent of Instructor

**Lab:** There is lab allotted as a part of this course

**Textbook:** Handouts and Notes

**Relationship of Course to Metallurgical and Materials Engineering Program Outcomes:**
This course introduces the theory and practice of the most commonly used basic/advanced analytical techniques by metallurgical and materials engineers.

**Objectives:** The objective of this course is to provide the student with:
- a sound understanding of the basic principles of X-ray, ICP, SEM techniques and measurements,
- a qualitative and quantitative understanding of the advantages, limitations, and differences/similarities between them.

**Outcomes:** Graduates of the course will:
- understand the X-ray method principles, characteristics and measurement including safety procedures for single phase and multiphase alloys/compounds analysis,
- understand ICP method principles, characteristics, and measurement including EPA (Environmental Protection Agency) analytical procedures for single and multiphase alloys/compounds,
- understand the basic principles and operational procedure for analyzing materials using SEM,
- fulfill **ABET outcomes** a, b and l (consult the Course Catalog and Department Guidelines)
Tentative Lecture Course Contents

1. **X-Ray Diffraction** *(8-10 lectures)*
   
   1.1 Introduction
   1.1.1 Characteristic Radiation
   1.1.2 Crystal Structure
   
   1.2 Components of an X-Ray Diffractometer
   1.2.1 X-Ray Source
   1.2.2 Specimen
   1.2.3 Optics
   1.2.4 Detector
   
   1.3 Standard Pattern
   1.3.1 Data Collection
   1.3.2 Crystal Structure
   1.3.3 Powder Mixture Identification
   
   1.4 Data Collection and Phase Identification
   1.4.1 Sample Preparation
   1.4.2 Data Collection
   1.4.3 Phase Identification

2. **ICP/Others** *(8-10 lectures)*
   
   2.1 ICP
   2.1.1 Introduction
   2.1.2 Characteristic Radiation
   2.1.3 Equipment/Procedures
   2.1.4 QA/QC
      2.1.4.1 Requirements
      2.1.4.2 Procedures
   
   2.2 Ion and Gas Chromatographs
   2.3 Specific Ion Electrode
   2.4 Carbon/Sulfur Analyzer

3. **SEM/EDX/XPS/Other** *(8-10 lectures)*
   
   3.1.1 SEM/EDX
   3.1.2 Theory
   3.1.3 Practical Analyses
Laboratory Schedule (~18 labs)

~13 labs: ~5 labs X-Ray Diffraction, ~5 labs ICP, ~3 labs SEM/EDX/XPS/Other

- Introduction to X-ray Diffraction Equipment/Safety, sample prep: Demo (No report required)
- Module 1: Determination of Crystal Structure, Indexing of Patterns (Run the system on your own metal, collect data, index planes, identify crystal structure, use card file for identification, REPORT required)
- Module 7: Quantitative Analysis of Powder Mixtures (Run the system using mixture; determine quantitatively the amounts of each present, REPORT required)
- Identification of Compounds in a Mixture: Demo on a Mixture of Compounds and Demo on Use of Jade Software (No report required)
- Module 8: Identification of your own Unknown Mixture (Run the system on your mixture, collect data, and identify compounds present, REPORT required)

Assessment:
Lecture
[3 Tests (~20% each) & a term paper 15]: 75%
Laboratory reports: 25%
Total: 100

Excessive absence will result in lowering of the final grade.

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
- 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 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, Ipods, 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.

**Requirement:**
1. Attend at least 90% of the classes.
2. Attend all tests/exams.
3. **Talking with other students during lecturing in class is prohibited and is considered disruptive behavior.**

**Contribution to Professional Component:**

- Engineering Topics- Yes
- Engineering Design- Yes (Introductory)
- Computer Usage- Yes
- Ethics- No
- Statistics- No
- Safety- No

**ABET outcomes covered:** a, b and l

**Prepared by:** Dr. Sudhakar K.V.  
**Date:** January 10th, 2011