

MTE 481 (W) – Analytical Methods for Materials
FALL SEMESTER 2011

Catalog Description: MTE 481. Analytical Methods for Materials (2-3) Three Hours. Crystallography, physics of X-rays, diffraction by crystalline materials, applications of X-ray, electron and neutron diffraction, and spectrometric analysis of materials. 3 hours.

Prerequisites: MTE 271 and 373 or permission of the instructor

Instructor: Mark L. Weaver; Room 1108 Bevill; 348-7073; email: mweaver@eng.ua.edu

Lectures: MWF 8:00 am – 8:50 am; 0058 Bevill

Labs: F 1:00 pm – 3:00 pm; F 3:00 pm – 5:00 pm

Office Hours: F 9:00 am – 11:00 am or by appointment

Course Objectives: At the conclusion of this course, students will be able to characterize the structures and chemistries of materials using traditional analytical experimental techniques.

List of Lecture Topics (Provisional):

1. Crystallography
2. X-ray diffraction
3. Light optical microscopy
4. Scanning electron microscopy
5. Transmission electron microscopy
6. X-ray spectroscopy for chemical analysis
7. X-ray photoelectron spectroscopy and auger electron spectroscopy
8. Technical Communication Skills

List of Laboratories (Provisional):

1. Crystal Structure Determination via X-ray Diffraction
2. Lattice Parameter Determination and Phase Diagram Determination
3. Determination of Crystallize/Grain Size and Lattice Strain
4. Quantitative Analysis of Powder Mixtures
5. Metallography and Optical Microscopy
6. Scanning Electron Microscopy and X-ray Analysis in an Electron Microscope
7. Identification of an Unknown Material (Final Project)

Quizzes, Laboratories, Reports, and Grading

- **Quizzes:** (30% of grade) Up to four 50 minute quizzes (graduate students will have additional ‘take home’ sections for each exam).
- **Laboratories:** (30% of grade) Several laboratories will be conducted in this course. Most will involve X-ray Diffraction. **Individual written lab reports will be required for each laboratory.** Lab reports will be graded individually. As this is a W-designated course, **all students must demonstrate the ability to write coherent, logical, properly edited sentences with proper referencing.** Reports must be written in accord with *Reporting Results* by D.C. VanAken and W.F. Hosford. Reports will be assessed using the MTE 481 ABET rubrics. I will hand them out to the class.
- **Final Project:** (40% of grade) There will be one final project. This will be a group activity. There is a required group project report and group project presentation.

Quizzes	30%
Laboratory Reports	30%
Final Project Report and Presentation	40%
Total	100%

Grading Scale:

	A+	≥ 98%	73% ≤	C	< 77%
93% ≤	A	< 97%	70% ≤	C-	< 73%
90% ≤	A-	< 93%	67% ≤	D	< 70%
				+	
87% ≤	B+	< 90%	63% ≤	D	< 67%
83% ≤	B	< 87%	60% ≤	D-	< 63%
80% ≤	B-	< 83%	60% <	F	
77% ≤	C+	< 80%			

Class Policies: Attendance at examinations and laboratories is mandatory. If you must miss a scheduled laboratory or quiz due to serious illness, family death, accident, etc., notify Professor Weaver as soon as possible. Excuses of a non-urgent nature will not be accepted.

Quiz questions will primarily be of the short answer variety.

Cellular phones must be turned off during lectures, laboratories, and quizzes/examinations.

Late items will not be accepted.

Do not plagiarize or cheat. If you do, I will flunk you.

Disabilities: Students with disabilities who may require more time than is allotted for the exams/quizzes must contact the UA Office of Disability Services (ODS) to obtain PRIOR APPROVAL and THE PROPER PAPERWORK in accordance with the rules and regulations of The University of Alabama. Alternate exams/quizzes must be scheduled through the ODS (348-4285).

Required Text(s)

1. Y. Leng, *Materials Characterization*, John Wiley & Sons, Hoboken, NJ, 2008.
2. Y. Waseda, E. Matsubara, and K. Shinoda, *X-ray Diffraction Crystallography*, Springer, New York, NY, 2011.
3. D.C. Van Aken and W.F. Hosford, *Reporting Results*, Cambridge University Press, Cambridge, UK, 2008.

Other Reference Texts

1. D. Brandon and W.D. Kaplan, *Microstructural Characterization of Materials*, 2nd Edition, John Wiley & Sons, Hoboken, NJ, 2008.
2. C. Hammond, *The Basics of Crystallography and Diffraction*, 3rd Edition, Oxford University Press, Oxford, UK, 2009.
3. R. Tilley, *Crystals and Crystal Structures*, John Wiley & Sons, Hoboken, NJ, 2006.
4. D.B. Cullity and S.R. Stock, *Elements of X-ray Diffraction*, 3rd Edition, Prentice Hall, Upper Saddle River, NJ, 2001.

5. P.E.J. Flewitt and R.K. Wild, *Physical Methods for Materials Characterization, 2nd Edition*, Institute of Physics, Philadelphia, PA, 2003.
6. C. Suranarayana and M.G. Norton, *X-ray Diffraction A Practical Approach*, Plenum Press, New York, NY, 1998.
7. R.F. Egerton, *Physical Principles of Electron Microscopy*, Springer, New York, NY, 2005.
8. P.J. Goodhew, J. Humphreys, and R. Beanland, *Electron Microscopy and Analysis, 3rd Edition*, Taylor and Francis, London, UK, 2001.
9. D.J. Dyson, *X-ray and Electron Diffraction Studies in Materials Science*, Maney Publishing, London, UK, 2004.
10. A.D. Krawitz, *Introduction to Diffraction in Materials Science and Engineering*, John Wiley & Sons, Hoboken, NJ, 2001.
11. M. DeGraef and M.E. McHenry, *Structure of Materials*, Cambridge University Press, Cambridge, UK, 2007.
12. *Industrial Applications of X-ray Diffraction*, edited by F.H. Chung and D.K. Smith, Marcel Dekker, New York, 2000.
13. C. Kittel, *Introduction to Solid State Physics, 7th Edition*, John Wiley & Sons, Hoboken, NJ, 1996.
14. R. Jenkins and R.L. Snyder, *Introduction to X-ray Powder Diffractometry*, John Wiley & Sons, Hoboken, NJ, 1996.
15. C. Barrett and T.B. Massalski, *Structure and Properties of Metals, 3rd Edition*, McGraw-Hill, 1966.
16. V.K. Pecharsky and P.Y. Zavilij, *Fundamentals of Powder Diffraction and Structural Characterization of Materials, 2nd Edition*, Springer, New York, 2008.
17. B.B. He, *Two-Dimensional X-ray Diffraction*, John Wiley & Sons, Hoboken, NJ, 2009.
18. M. Birkholz, *Thin Film Analysis by X-ray Scattering*, Wiley-VCH, Weinheim, FRG, 2006.
19. O. Engler and V. Randle, *Introduction to Texture Analysis, 2nd Edition*, CRC Press, Boca Raton, FL, 2010.
20. D.B. Williams and C.B. Carter, *Transmission Electron Microscopy, 2nd Edition*, Springer, New York, 2009.
21. B. Fulz and J.M. Howe, *Transmission electron Microscopy and Diffractometry of Materials, 3rd Edition*, Springer, New York, 2008.
22. E. Zolotoyabko, *Basic Concepts of Crystallography*, Wiley-VCH, Weinheim, Germany, 2011.
23. L-L. Ooi, *Principles of X-ray Crystallography*, Oxford University Press, Oxford, UK, 2010.
24. C. Suranarayana and M.G. Norton, *X-ray Diffraction A Practical Approach*, Plenum Press, New York, NY, 1998.
25. C. Suranarayana, *Experimental Techniques in Materials and Mechanics*, CRC Press, Boca Raton, FL, 2011.