

DEPARTMENT: MECHANICAL ENGINEERING	
COURSE #: EMA 4501 3 credits Course Website	COURSE TITLE: Electron Microscopy
TYPE COURSE: Technical Elective UG Track Certification area: Mechanics and Materials	TERMS OFFERED: Spring
CATALOG DESCRIPTION: Fundamentals and techniques of electron microscopy as applied to the determination of physical, chemical, and structural properties of materials and materials behavior in practice.	PREREQUISITES: EML 3234 Materials Science and Engineering. Or instructor permission.
AREA COORDINATOR: Dr. William Oates RESPONSIBLE FACULTY: Dr. Fumitake Kametani INSTRUCTOR OF RECORD: Dr. Fumitake Kametani COE B316 (850) 645-7491 fkametani@fsu.edu Office Hours: Will be announced at the first class. Walk in at the office hours or contact me by email. DATE OF PREPARATION: 11/18/2016 (FK)	CLASS SCHEDULE: Class: Two times weekly for 1 hr. and 15 min Lab: May have demo sessions of SEM and TEM
TEXTBOOKS/REQUIRED MATERIAL: • <i>None</i> References, Additional Resources (on Reserve): • Transmission Electron Microscope, D. B. Williams and C. B. Carter, 2nd Edition, Springer (2009) • Scanning Electron Microscopy and X-ray Microanalysis, J. Goldstein et al., 3rd Edition, Springer (2003)	SCIENCE/DESIGN (%): 100% / 0% CONTRIBUTION TO MEETING THE PROFESSIONAL COMPONENT: 100% engineering science 0% engineering design
COURSE TOPICS: The topics to be covered are following (shown in the order to be lectured); 1. Basic concept of scanning electron microscopy (SEM) 2. Basic concept of transmission electron microscope (TEM) 3. Electron beam-specimen interaction in SEM and TEM 4. Image formation in SEM 5. Crystallography, diffraction and reciprocal space 6. Basic concept of dislocation 7. Image contrasts of crystalline materials in TEM 8. Basic concept of Kikuchi diffraction and its applications 9. Advanced imaging and analytical techniques	ASSESSMENT TOOLS: Undergraduate: EMA 4501 1. Homework (25%) 2. Two exams (50%) 3. Final exam (25%)
Student Learning Objectives for FSU Curriculum File Syllabus	Upon Completion of this course, students should be able; 1. To use the fundamental concept of SEM and TEM as a research tool. 2. To be able to state the electron beam-material interaction in SEM and TEM. 3. To be able to extract nanostructural information from SEM images.

	<ol style="list-style-type: none"> 4. To be able to classify the crystallography for examinations in TEM. 5. To be able to state the fundamental concept of electron diffraction and reciprocal space. 6. To be able to distinguish the dislocation-related contrasts in TEM images. 7. To be able to extract nanostructural information from the imaging contrasts, diffraction and defects in TEM. 8. To be able to identify the Kikuchi diffraction and to be able to adopt the related techniques for material analyses. 9. To be able to use the advanced imaging and analytical techniques in SEM and TEM as a method of researches.
Justification for addition or change	<p>Nowadays, precise control of nanostructures becomes more and more important in the material engineering. Scanning electron microscope (SEM) and transmission electron microscopy (TEM) are the essential tool to understand the nanostructural correlations to materials properties such as mechanical, electrical, magnetic etc. Course is needed in order that students can carry out such nanostructural and nanochemical analyses on their real materials with using SEM and/or TEM.</p>
Level of computer usage: Modes of Instruction: Core Curriculum Course: Availability to other Majors:	<p>None <input type="checkbox"/> Elementary <input checked="" type="checkbox"/> Intermediate <input type="checkbox"/> Advanced <input type="checkbox"/> Lecture <input checked="" type="checkbox"/> Lab <input type="checkbox"/> DIS <input type="checkbox"/> Discussion <input type="checkbox"/> Other <input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p>
ME COURSE OBJECTIVES* [related to ABET Student Outcomes]	<p>Numbers shown in brackets refer to department Student Outcomes on web site http://www.eng.fsu.edu/me/about_us/accred-info.html</p> <ol style="list-style-type: none"> 1. To introduce the fundamental concept of scanning and transmission electron microscope (SEM and TEM) [10] 2. To understand how electrons interact with elements in materials [1] 3. To understand how to extract nanostructural information from SEM images [2, 10] 4. To summarize the basic concept of crystallography [1] 5. To introduce the fundamental concept of electron diffraction and reciprocal space [1] 6. To summarize how dislocation-related contrasts form in TEM images [1] 7. To understand the relations between imaging contrasts, diffraction and defects in TEM [10] 8. To introduce the basic concept of Kikuchi diffraction and its applications in material analyses [1, 10] 9. To introduce other advanced imaging and analytical techniques in SEM and TEM [2, 5, 10] <p>Numbers refer to the Departmental Student Outcomes, e.g. for course objective 3, [1, 5] refers to student outcomes 1 and 5.</p>
COURSE OUTCOMES ABET * = Course Objectives for FSU Curriculum File Syllabus	<p>*(Numbers shown in brackets are links to Course Objectives above)</p> <p>Upon Completion of this course, students should be able;</p> <ol style="list-style-type: none"> 1. To use the fundamental concept of SEM and TEM as a research tool [1] 2. To state the electron beam material interaction in SEM and TEM [2] 3. To extract nanostructural information from SEM images [3] 4. To classify the crystallography for examinations in TEM [4] 5. To state the fundamental concept of electron diffraction and reciprocal space [5] 6. To distinguish the dislocation-related contrasts in TEM images [6] 7. To extract nanostructural information from the imaging contrasts, diffraction and defects in TEM [7] 8. To identify the Kikuchi diffraction and to be able to adopt the related techniques for material analyses [8] 9. To use the advanced imaging and analytical techniques in SEM and TEM as a method of researches [9] <p>Numbers refer to Course Objectives above, e.g. for course outcome 1, [1, 3] refers to course objectives 1, 3.</p>

ASSESSMENT TOOL DETAILS

GRADING/ EVALUATION:

Homework assignments (25% for EMA4501):

- We will have homework assignments most weeks. In general, the problems will be assigned after each theme or section, and will be due one week later. Homework turned in after this is late and will automatically lose 25% of the possible points for each day it is late. I DO NOT accept homework electronically.

Major exams (75% for EMA4501):

There will be 2 midterm exams (25% per each for EMA4501) and one final exam (25% per each for EMA4501) during the semester.

EMA4501
1) Homework problems (25%)
2) Exam 1 (25%)
3) Exam 2 (25%)
4) Final (25%)

Extra Credit:

No extra credit given in this course.

Letter grades will be assigned equivalent to the following:

Undergraduate Grading Scale	
Numerical Score	Letter Grade
90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
0 - 59	F

Departmental policy is that a grade of C or better is required to pass this course.

College of Engineering Undergraduate Policy:

- It is the policy of the College not to assign “plus and minus (+/-)” grades for undergraduate engineering courses. <http://www.eng.fsu.edu/current/undergraduate/guide.html>, see Grading Policies.
- Students are required to be familiar with Academic Policies and Requirements as outlined in the COE Student Handbook <http://www.eng.fsu.edu/current/undergraduate/guide.html> page 11

ASSIGNMENTS/RESPONSIBILITIES:

Student Responsibilities

- Separate notebook is required (will be inspected – 10% of grade)
 - I believe that poor performance starts with poor notes
 - My expectation is that all of you will take notes as I speak, even if only brief, skeletal notes
 - You need to flesh out the skeletal notes with detail later
 - I advise a multilevel (3-5) outline format

- Attendance: I will not take role to call attendance in class. However, turning in homework will be considered as your attendance.
- Homework: Each person must write out their answers in their own way without copying (in such cases all papers involved will be graded zero). I will post answers on Blackboard after hand in but will not grade it.
- Exams

Assessment Tool:

1. Homework
2. Exams

Examinations:

You will have two mid-term exams and one final exam. The tentative dates for the mid-term exams are given below. They may change forward or backward depending on how the course progresses.

- Midterm 1 – Monday Feb. 6, 2017
- Midterm 2 – Monday, March 27, 2017
- Final exam

Final Examination: on the COE exam date see http://www.eng.fsu.edu/current/exam_schedule.html

Grading Philosophy:

- Engineering is a PROFESSION – professional presentation of your arguments is expected!
 - Material should be legible and logical and look sharp!
 - Explanations are expected so that it is easy to follow. I am not prepared to wade through unprofessional work.
 - Handed in work should be neat, tidy, stapled and generally material that you should be proud of!
- We encourage THINKING and THOUGHTFULNESS so will credit these qualities
- We expect all work handed in for credit to be your work and not copied, plagiarized or otherwise tainted.

Email Etiquette:

All email in this class from me to you and from you to me requires the following items.

- a. Subject heading that includes (1) EML 4930 or EML 5930 and (2) a description of the email content
- b. The body of the email requires the following elements:
 - i. A salutation designating to whom the email is addressed (e.g. Dear ...)
 - ii. The body of the email.
 - iii. A complementary closing (e.g. Sincerely Yours, Best Wishes...)
 - iv. The name of the person who wrote the email.

All of these elements are required for professional correspondence. I will not respond to email that is missing any of these elements.

Kametani Travel:

I will be out of town a few days during the semester. I may have a guest lecturer when I am gone, or leave a lecture for you on Blackboard. Or I may have a guest lecturer or technician to do demo of SEM, TEM or related techniques.

Electronic Devices:

Unless instructed by the lecturer, no phones, tablets, or computers are allowed in class. If you want to use a tablet to take notes, let me know. But I encourage you to write down on your notebook. In the past, students who have used computers and tablets have not done well in the class.

COURSE POLICIES:

Attendance Policy:

First day attendance is mandatory for FSU students, and first week attendance is mandatory for FAMU students. Students not in class during the first day (FSU) or first week (FAMU) are to be dropped from the course.

Excused Absences: Excused absences include documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University

activities. Accommodations for these excused absences will be made and will do so in a way that does not penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Please note that the College of Engineering has a restrictive interpretation of what is considered a valid excuse for an absence. See: <http://www.eng.fsu.edu/current/undergraduate/guide.html> p. 5. If an absence is to be excused, make sure you check beforehand. In case of excused absence, the instructor will work with you to help you make up for missed time and catch up.

Unexcused Absences: A student having more than four unexcused absences will be dropped from the course and assigned the grade F. No exceptions. Tests and exams missed because of unexcused absence receive the grade 0. No exceptions.

Other projects and activities missed completely receive the grade 0 for those projects or activities. No exceptions.

Other Regulations

Note that the penalties for copying work may result in a failing grade for the course. If you are uncertain, please check with the instructor who assigned the work. Working together is encouraged in this course, but blatant copying is not.

Departmental Policy:

A student may continue in the B.S. in ME degree program unless one or more of the following conditions arise;

- a. A grade below C in the second attempt of the same engineering course
http://www.eng.fsu.edu/me/resources/pdf/ME_Prerequisite_Policy.pdf
- b. More than three (3) repeat attempts in engineering courses.
http://www.eng.fsu.edu/me/resources/pdf/ME_Excessive_Repeat_Policy.pdf
- c. Violation of academic honor code as defined in university bulletin or catalog
- d. Use of grade forgiveness (currently available for FAMU students only) in more than two (2) courses.

Make-up Assignments

A make-up examination may be granted to students with a valid excused absence. However, you must notify me in advance if your absence involves a planned event or observance of a religious holy day. If an emergency prevents you from attending a scheduled examination, you must notify me at your earliest opportunity. You must obtain a valid excused absence for the emergency to be eligible for a make-up examination. Students with a valid excused absence will not be arbitrarily penalized for missing an assignment.

Instructional Method(s)

The primary instructional method is a traditional in-class lecture. There will also be extensive use of the Blackboard web delivery system for distribution of course assignments and other materials. Course materials available from the textbook publisher may also be used. The use of online instructional techniques will be introduced.

COURSE SCHEDULE

Week	Topics to be covered (not necessarily in the order shown)
1	Structure of crystalline solids
2	Dislocations and strengthening mechanisms
3	Basic concept of scanning electron microscopy
4	Electron beam-specimen interaction in SEM
5	Image formation in SEM
6	Basic concept of transmission electron microscope
7	Electron scattering and diffraction

8	Elastic and inelastic scattering
9	Basic concept of dislocations
10	Crystallography and reciprocal space
11	Diffraction from crystals and from small volumes
12	Imaging contrasts in TEM
13	Phase contrast and high resolution TEM
14	Planar defects and precipitates
15	Imaging dislocations and strain fields

DEPARTMENTAL STUDENT OUTCOMES

The department's student outcomes can be found at
http://www.eng.fsu.edu/about/accreditation/program_outcome.html?ID=215&agency=ABET

Program Outcomes/Student Learning Outcomes

Student learning outcomes for students majoring in engineering may be found at
<http://www.eng.fsu.edu/outcomes>

Location of Academic Learning Compacts (ALC)

COE: http://www.eng.fsu.edu/about/accreditation/program_outcome.html?ID=217&agency=ALC
 FAMU: <http://www.famu.edu/index.cfm?Assessment&CurrentALCs#engineering>
 FSU: <http://learningforlife.capd.fsu.edu/smalcs/learningCompact.cfm?smalcId=62534>

ACADEMIC HONOR POLICY

Students are expected to uphold the University Student Code of Conduct and/or University Academic Honor Code

The Florida A&M University is committed to academic honesty and its core values which include scholarship, excellence, accountability, integrity, fairness, respect, and ethics. These core values are integrated into its academic honesty policy. Being unaware of the Academic Honesty Policy is not a defense to violations of academic honesty. Academic Honesty Policy violations shall be reported and appropriate actions taken by the Department Chair and Associate Dean for Student Affairs and curriculum. The complete Florida A&M Student Code of Conduct - Regulation 2.012 (8a) can be found on (p. 5)

http://www.famu.edu/judicialAffairs/Regulation%202_012%20Student%20Code%20of%20Conduct.pdf and in the Student Handbook "The Fang" p. 61

<http://www.famu.edu/Students/STUDENT%20HANDBOOK%20%28FANG%29%202012-2014.Updated%208.22.13.pdf> p 61

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at <http://fda.fsu.edu/Academics/Academic-Honor-Policy>.)

AMERICANS WITH DISABILITIES ACT

During the first week of class students with disabilities needing academic accommodation should:

- 1) register with and provide documentation to the **LDEC** or **SDRC**; and
- 2) bring a letter to the instructor indicating the need for accommodation and what type.

Please note that instructors are not allowed to provide classroom accommodation to a student until appropriate verification from the Student Disability Resource Center has been provided.

For more information about services available to FAMU students with disabilities, contact **The Learning Development and Evaluation Center (LDEC)**

677 Ardelia Court Florida A&M University Tallahassee, FL 32310 Nathaniel Holmes, Director Donna Shell, Asst. Director	599-3180 (phone) 561-2512 (fax) 561-2783 (TDD) http://www.famu.edu/index.cfm?a=EOP&p=ADA
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For more information about services available to FSU students with disabilities, contact the:
Student Disability Resource Center (SDRC)

874 Traditions Way 108 Student Services Building Florida State University Tallahassee, FL 32306-4167	(850) 644-9566 (voice) (850) 644-8504 (TDD) sdrc@admin.fsu.edu http://www.disabilitycenter.fsu.edu/
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This syllabus and other class materials are available in alternative format upon request.

UNIVERSITY'S NON-DISCRIMINATION POLICY STATEMENT

FAMU: <http://www.famu.edu/index.cfm?EOP&NON-DISCRIMINATIONPOLICYSTATEMENT>

FSU: http://www.hr.fsu.edu/PDF/Publications/diversity/EEO_Statement.pdf

SYLLABUS CHANGE POLICY:

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advanced notice.