M A T E R I A L S

DEPARTMENT

GRADUATE STUDENT MANUAL

Fall 2003

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MATERIALS

Who’s Who in the Materials Department

THE MATERIALS DEPARTMENT
FACULTY

		Joint Appointment	Area
*	Frederick F. Lange (Chair)	ChE	Structural/Inorganic
*	Carlos G. Levi (Assoc. Chair)	MEE	Structural/Inorganic
	Guillermo C. Bazan	Chem	Macro/Biomolecular
*	Anthony Cheetham	Chem	Inorganic/Structural
*	David R. Clarke	—	Electronic/Inorganic/Structural
	Larry A. Coldren	ECE	Electronic
*	Timothy Deming	Chem/BMSE	Macro/Biomolecular
*	Steven P. DenBaars	ECE	Electronic
*	Anthony G. Evans	ME	Structural
	Glenn H. Fredrickson	ChE	Macro/Biomolecular
*	Arthur C. Gossard	ECE	Electronic
	Alan J. Heeger	Phys	Macro/Biomolecular/Electronic
	Evelyn L. Hu	ECE	Electronic
	Jacob N. Israelachvili	ChE	Macro/Biomolecular
*	Edward J Kramer	ChE	Macro/Biomolecular/ Structural
	Herbert Kroemer	ECE	Electronic
	James Langer	Phys	Electronic
	L. Gary Leal	ChE	Macro/Biomolecular
	Glenn E. Lucas	MEE/ChE	Structural
*	Noel MacDonald	MEE	Structural/Electronic
	Robert M. McMeeking	MEE	Structural
	John McTague	—	Inorganic
	Frederick Milstein	MEE	Structural
*	Shuji Nakamura	ECE	Electronic
	G. Robert Odette	MEE	Structural
*	Pierre M. Petroff	ECE	Electronic
	Philip A. Pincus	Phys/BMSE	Macro/Biomolecular
	David Pine	ChE	Macro/Biomolecular
*	Cyrus R. Safinya	Phys/BMSE	Macro/Biomolecular
*	Ram Seshadri	—	Inorganic
*	Nicola A. Spaldin	—	Electronic/Inorganic
*	James S. Speck	—	Electronic/Inorganic
*	Susanne Stemmer	—	Inorganic
	Galen D. Stucky	Chem	Inorganic/Electronic
	Matthew V. Tirrell	ChE	Macro/Biomolecular
	Joseph Zasadzinski	ChE	Macro/Biomolecular
*	Francis W. Zok	—	Structural

* Majority appointment in the Materials Department

Emeriti:

James L. Merz	(now at Notre Dame Univesity)

TECHNICAL STAFF

Brian Carralejo	Metalorganic Chemical Vapor Deposition Laboratory
Mark Cornish	Microscopy / Specimen Preparation (SEM)
Mike Edwards	Computer Consultant
John English	Molecular Beam Epitaxy (MBE) Laboratory
Kirk Fields	Mechanical Testing Laboratory
Budd Jamieson	Computer Consultant
Youli Li	X-Ray Facilities
Tom Mates	Thin films and interfaces, SIMS and XPS
Peter Maxwell	Materials Processing
Deryck Stave	Structural Materials Processing Laboratory
Mario Yasa	X-Ray Facility
Jin-Ping Zhang	Microscopy Laboratory (TEM&AFM)

ADMINISTRATIVE STAFF

Denise Barcon	Management Services Officer (MSO)
McNie, Joanne	Assistant to Professors Deming, Hill, Pincus, and Safinya
Laura Cheung	Graduate Program Assistant
Carolyn Cunningham	Contracts & Grants Manager
Donna Dobis	Accounting/Contracts & Grants Assistant
Nicole Eby	Assistant to Professor Evans
Shannon Palomares	Administrator for the Interdisciplinary Center for Wide Band Gap Semiconductors; and Solid State Lighting Center
Mary Flores	Assistant to the Chair, Professor Lange, the Associate Chair, Professor Levi, and to Professor Zok
Maxine Kelley	Personnel Assistant
Lindsay Cahn	Assistant to Professors Petroff, Clarke, Speck,

	DenBaars & Nakamura; Center Assistant
Kathleen Spaulding	Travel Coordinator/Receptionist
Scott Smith	Clerk
Sarsinan Supkarnkitkun	Assistant to Professors Kramer, & Gossard; Assistant for Graduate Activities
Veniss Wilson	Purchasing Assistant

MATERIALS DEPARTMENT COMMITTEES

Academic Affairs Committee
Cyrus Safinya, Chair
Fred Lange
Jim Speck
Frank Zok

Admissions Committee
Steve DenBaars, Chair
Gui Bazan
Tony Evans
Ram Seshadri
Laura Cheung, Staff Representative

M A T E R I A L S

Introduction

THE UC SYSTEM

The University of California was chartered as a land-grant college in 1868. Nine UC campuses are now situated throughout the state, in Berkeley, Davis, Irvine, Los Angeles, Riverside, San Diego, San Francisco, Santa Barbara, and Santa Cruz. Together, the campuses have nearly 8,000 faculty members and a current enrollment of about 180,000 students. About one-fourth of UC students are studying at the graduate and professional level. The University also operates a variety of laboratories, agricultural field stations, extension offices, and other facilities. The University is the primary state-supported academic agency for research, and the preeminent system of public higher education in the country.

The nine UC campuses are governed by the Regents of the University of California, a corporate board of 26 members. The Regents in turn, delegate authority to the President, the Chancellor of each campus, and to the Academic Senate, which represents the faculty.

THE UCSB CAMPUS

The UCSB campus was established in 1944 and moved to its present location on the site of a former marine base in 1953. The 989 acre grounds include the main campus, the Santa Ynez and Storke apartments and the West campus. The student community of Isla Vista is surrounded by the UCSB campus and the Pacific Ocean.

Within its beautiful setting, the University of California, Santa Barbara is a major research institution offering undergraduate and graduate education in the arts, humanities, the social sciences, and science and technology. Large enough to have excellent facilities for study, research, and other creative activities, the campus is also small enough to foster close relationships among faculty and students. The total student population is about 19,000, with 16,500 undergraduates and 2,500 graduate students. The UCSB faculty numbers nearly 1,000 and includes three Nobel laureates, recipients of the National Medal of Science, members of the National Academy of Sciences and the National Academy of Engineering, members of the Royal Society of London, numerous Guggenheim fellows, Fulbright scholars, and fellows of the National Endowments for the Arts and for the Humanities.

The UCSB campus has 6 academic units: the College of Creative Studies, the College of Engineering, the College of Letters and Sciences, the Graduate School of Education, the School of Environmental Science & Management and the Graduate Division.

THE COLLEGE OF ENGINEERING

The College of Engineering is the second largest undergraduate college at UCSB, including approximately 1,500 undergraduate students and 550 graduate students. In recent years, the College has become one of the most dynamic engineering schools in the nation. It currently has approximately 116 faculty and consists of five degree-granting departments:

- Chemical Engineering
- Computer Science
- Electrical and Computer Engineering
- Materials
- Mechanical and Environmental Engineering

The College has three nationally funded Research Centers focused on Materials:

- Materials Research Laboratory
- Nanotech, UCSB Node of the National Nanofabrication Users' Network (NNUN)
- Optoelectronics Technology Center

In addition, the faculty in the college have formed interdisciplinary centers in the following areas:

- Center for Computational Modeling and Systems (Alexandria Digital Library)
- Center for Control Engineering and Computation
- Center for Entrepreneurship and Engineering Management
- Center for Information Processing Research
- Center for Non-Stoichiometric Semiconductors
- Center for Risk Studies and Safety
- Center for Robust Nonlinear Control of Aeroengines
- Compound Semiconductor Research Laboratories (COSEARCH)
- High Performance Composites Center
- Innovative Microwave Power Amplifier Consortium Center
- Interdisciplinary Center for Wide Band-Gap Semiconductors
- Mitsubishi Chemical Center for Advanced Materials
- Multidisciplinary Optical Switching Technology Center
- Ocean Engineering Laboratory
- Solid State Lighting and Displays Center
- Walsin Lihwa Electronics and Photonics Research Center

Recently, the State of California has funded the

- California Nanosystems Institute

THE MATERIALS DEPARTMENT

The Materials Department at UCSB was established as a Graduate Program in 1985, building on existing research programs in the College of Engineering as well as the Physics and Chemistry Departments. The Department was conceptualized and built under two basic guidelines: to educate graduate students in advanced materials and to introduce them to novel ways of doing research in a collaborative, multidisciplinary environment.

The Department is organized into four distinct--but not separate--groups specializing in electronic materials, macromolecular/biomolecular materials, structural materials and inorganic materials. Faculty, postdoctoral researchers, and students in the various specialties collaborate within and among these areas. Currently, the Materials Department has approximately 125 graduate students and 37 faculty, many of who have joint appointments with other departments. In addition, approximately 50 postdoctoral associates and visiting researchers are working within the department.

M A T E R I A L S

Graduate Program Information

PROGRAM OF STUDY

The Department of Materials offers programs leading to the M.S. or Ph.D. degree with specializations in the following major areas: electronic materials (semiconductors, superconductors, quantum structures and optoelectronic materials); inorganic materials (ferroelectrics, photonic and magnetic materials, and zeolite molecular sieves); macro/biomolecular materials (self-assembling polymers, biopolymers, biomembranes, and conducting polymers); and structural materials (metals, ceramics, intermetallics, composites, and coatings, including mechanics of materials). The curriculum in each area has the flexibility needed to provide multidisciplinary educational opportunities in the field of advanced materials, encompassing topics such as optoelectronic devices, composites, and micromechanics. Materials synthesis, processing and characterization feature prominently with courses in the processing of ceramics, alloys, composites, semiconductor materials, and polymers, as well as advanced topics in electron microscopy. Programs of study and research are individually tailored to accommodate research needs and student interest. Multidisciplinary education is strongly encouraged by means of joint faculty supervision of research and by the selection of courses. Students are also encouraged to cross over traditional boundaries into other departments on campus (for example, Electrical and Computer Engineering, Mechanical and Environmental Engineering, Chemical Engineering, Biology, Chemistry and Physics) through collaboration and taking courses in those departments as appropriate.

Incoming students are expected to design a tentative study program suitable to their interests and research field with the assistance of their advisor and submit it for approval to the Academic Affairs Committee within the first two quarters of residence. Students are expected to complete the Ph.D. program within five years after entry at the Bachelor’s level and within three years after entry at the Master’s level.

ADVISING AND ACADEMIC AFFAIRS

Decisions regarding the M.S./Ph.D. program and graduate student affairs reside with the Academic Affairs Committee. This committee consists of four faculty, including the Department Chair. The committee is responsible for approving examination and dissertation committees upon consultation with the student and research advisors. It is also the focus for discussions and recommendations concerning improvements in the graduate curriculum, examination procedures, etc.

You must select a research advisor(s) within your first quarter of enrollment, preferably earlier, based on mutual research interests and availability of research assistantships. Joint research advising by two faculty members is strongly encouraged to assure that research programs have a strong multidisciplinary character.

FIVE YEAR BS ENGINEERING/MS MATERIALS PROGRAM

In addition to completion of all requirements for the undergraduate program in chemical, electrical, or mechanical engineering, students must take Matrl 100A (or ECE 132 for ECE students) and Matrl 100B and 100C. In addition, they must take a minimum of 6 units of approved undergraduate elective courses. At the graduate level, students are required to 1.) complete 42 units approved by the department, including no fewer than 24 units of coursework numbered 200-299, no fewer than 3 and no more than 9 units of independent studies (Materials 596), and 2.) submit an acceptable engineering report based on their independent studies. Further details are available from the Department of Materials Graduate Affairs Office.

MASTER'S PROGRAM

The Master's degree requires successful completion of 42 units of academic work, of which 24 units are approved courses (excluding seminars and independent study), 6 units of seminars, and 12 units of thesis research. The thesis must be approved by a committee of three faculty, including the student's advisor(s). There is no oral defense of the M.S. thesis. See the appropriate Course track from the following pages in planning a program of study.

Ph.D. PROGRAM

Students admitted with a Bachelor's degree are required to complete a minimum of 66 units of academic work structured in the following manner: 36 units of 200-level courses (excluding seminars and independent study), 15 units of seminars and/or independent studies, and 15 units of thesis research. Up to 8 units of upper division undergraduate courses may be taken for credit toward the 200 level course requirements with prior approval of the student's advisor. In developing an appropriate, interdisciplinary course of study, doctoral students are expected to take all the available courses in their major area of interest as well as courses designed to broaden their knowledge of other materials. Individual students are required to develop their study plan in conjunction with their faculty advisor. Most courses will be selected from the main sequence of courses (offered every year) from one of the four principal areas of emphasis in the Department. Students should also not miss the opportunity to take any general or more specialized courses offered on a less frequent basis. The study plan must be approved by the faculty advisor and the department graduate advisor, although it may be modified during the course of the student's program. Students entering with a M.S. degree may petition to waive certain unit requirements for the Ph.D. (up to 15 units of 200-level courses and a possible six units of seminars) deemed to have been fulfilled by Master's studies elsewhere. See the appropriate Course track from the following pages in planning a program of study.

Electronic Materials Course track

Course Number	Course Title	Units
Main Sequence Courses:		
201	Thermodynamics & Phase Equilibria	3
206AB	Fundamentals of Electronic Solids I, II	4
211AB	Engineering Quantum Mechanics I, II	4
213	Crystal Growth & Thin Film Epitaxy	3
215ABC	Semiconductor Device Processing	4
General Courses:		
202	Kinetic Processes in Materials	3
209A	Diffraction Methods	3
209B	X-Ray Diffraction	3
209C	Electron Microscopy	3
216A	Defects in Materials	3
219	Phase Transformations	3
228	Computational Materials	3
279	X-ray, Electron, Neutron & Light Scattering	3
250	Transport Phenomena in Materials Processing	3
Specialized Courses:		
204	Introduction to Magnetism and Magnetic Materials	3
205	Wide-Band Gap Materials	3
216B	Defects in Semiconductors	3
217	Molecular Beam Epitaxy & Band Gap Engineering	3
226	Electrical & Optical Properties of Oxides	3
227	Vapor Phase Epitaxy of Electronic Materials	3
288AA-ZZ	Special Topics in Electronic Materials	3

Background Courses:

105 (ECE)	Statistical Thermodynamics	4
162A	Quantum Description of Electronic Materials	4
162B	Fundamentals of Solid State	4
162C (ECE)	Optoelectrical Materials and Devices	4

Inorganic Materials Course track

Course Number	Course Title	Units
Main Sequence Courses:		
201	Thermodynamics & Phase Equilibria	3
208	Crystallography & Structure Determination	4
218	Introduction to Inorganic Materials	3
222A	Colloids & Interfaces I	3
274	Solid State Inorganic Materials	3
279	X-ray, Electron, Neutron & Light Scattering	3
General Courses:		
202	Kinetic Processes in Materials	3
209A	Diffraction Methods	3
209C	Electron Microscopy	3
216A	Defects in Materials	3
219	Phase Transformations	3
226	Electrical & Optical Properties of Oxides	3
228	Computational Materials	3
251A	Ceramic Processing	
Specialized Courses:		
203	Transition Metal Oxides	3
216A (ChE)	Intro. to Magnetic Resonance Spectroscopy Tech.	3
251B	Densification & Microstructural Control	3
286AA-ZZ	Special Topics in Inorganic Materials	3
Background Courses:		
175 (CHEM)	Physical Methods in Chemistry	3

Macromolecular/Biomolecular Materials Course track

Course Number	Course Title	Units
Main Sequence Courses:		
271A	Synthesis & Properties of Macromolecules	3
271B	Structure & Characterization of Complex Fluids	3
271C	Properties of Macromolecules	3
General Courses:		
222A-B	Colloids and Interfaces. I, II, III	3-3
228	Computational Materials	3
239	Light Scattering in Complex Fluids	3
273	Experiments in Macromolecular Materials	3
275	Polymer Physics	3
279	X-ray, Electron, Neutron & Light Scattering	3
Specialized Courses:		
238A-B	Rheology of Polymeric Liquids	3
253	Liquid Crystals Materials	4
276A	Biomolecular Materials I: Structure & Function	3
276B	Biomolecular Materials II: Applications	3
277	Synthesis of Biomolecular Materials	3
278	Interactions in Biomolecular Complexes	3
282	Transition Metal Catalyzed Polymerization	3
284	Synthetic Chemistry of Macromolecules	3
287AA-ZZ	Special Topics in Macromolecular Materials	3
Background Courses:		
102 (ChE)	Biomaterials & Biosurfaces	3
135	Biophysics and Biomolecular Materials	3
144 (PHYS)	Complex Fluids	3
160 (ChE)	Introduction to Polymer Science	3
225 (ChE)	Biomedical Engineering	3

Structural Materials Course track

Course Number	Course Title	Units
Main Sequence Courses:		
201	Thermodynamics & Phase Equilibria	3
202	Kinetic Processes in Materials	3
207	Continuum Mechanics	3
220	Mechanical Behavior of Materials	3
General Courses:		
209A	Diffraction Methods	3
209C	Electron Microscopy	3
216A	Defects in Materials	3
219	Phase Transformations	3
279	X-ray, Electron, Neutron & Light Scattering	3
250	Transport Phenomena in Materials Processing	3
Specialized Courses:		
230	Elasticity	3
232	Plasticity	3
234	Fracture Mechanics	3
237	Advanced Deformation & Fracture	3
240	Finite Element Structural Analysis	3
251A	Ceramic Processing	3
251B	Densification & Microstructural Control	3
261	Composite Materials	3
262	Structural Ceramics	3
264	Reliability & Degradation of Materials	3
266	Advanced Solid Mechanics	3
285	Structure & Properties of Interfaces	3
289AA-ZZ	Special Topics in Structural Materials	3

Registration Information

Registration is completed by phone using the RBT system or on the web via the GOLD system. Complete instructions on this process can be found in the Schedule of Classes, which is printed quarterly by the Office of the Registrar. In addition to your elective courses, you must register for one unit of Materials (Matrls) 290 every quarter you are in residency in order to receive credit for attending group meetings and seminars. Every student must also enroll in at least one unit of either Matrls 598 or Matrls 599 every quarter after having selected an advisor and having begun research. In total, you must register for a minimum of 12 units each quarter. You should register for enough units in Matrls 598 or Matrls 599 to bring your quarter total to at least 12 units. All students should register for Matrls 598 until they have advanced to candidacy by passing the qualifying examination, after which they register for Matrls 599. Also, while serving as a teaching assistant, each student must register for Materials 501 under the instructor in charge of the class (see below).

Foreign Language

There is no foreign language requirement in either the M.S. or Ph.D. program. However, doctoral students are encouraged to become proficient in one or more foreign language relevant to the technical literature in their field. Students having a particular interest in strengthening their background in foreign languages for this purpose are encouraged to pursue the necessary coursework to fulfill that interest.

Special Preparation for Teaching

Students are required to act as Teaching Assistants for at least one quarter while in residence at UCSB (usually during the first year), in either Materials courses or within departments providing courses consistent with the student's undergraduate background. To receive credit for the required teaching, each student must register Materials 501 under the instructor in charge of the class, while serving as a teaching assistant. (These units may not be counted towards the 66 units of academic work required for graduation). Teaching assistants supervise labs, conduct recitation, tutor undergraduate students and give seminars. Because this is a requirement of the program, students' stipends will remain unchanged while serving as Teaching Assistants.

Students are also required to present research seminars, thereby ensuring that experience be gained in organizing and presenting lectures. Seminars are required at the group level (about one per quarter), the program level (one per year) and at conferences. Such activities enable students to improve the skills necessary for the subsequent pursuit of teaching opportunities.

Research

The University of California, Santa Barbara is classified as a Research University I by the Carnegie Mellon Foundation for the Advancement of Teaching. The Department of Materials is committed to research that advances the understanding and knowledge of materials in a collaborative, multidisciplinary environment. Students learn first-hand the theoretical and experimental foundations of one or more areas of materials and how to bring this knowledge to fruition in an interactive research setting.

The Materials Department holds certain expectations and standards regarding students' research. It is suggested that you discuss this in further detail with your advisor.

Preliminary Examination

The Preliminary Examination is administered in an oral format and consists of three sections comprising sub-areas within the student's major field of study. For the purposes of the Preliminary Examination the following are defined as the major fields of study within the Materials Department: Electronic/Photonic, Inorganic, Macro/Biomolecular, and Structural Materials. Four sub-areas have been defined within each major field to examine the student's fundamental knowledge of Materials, with emphasis on the materials and properties most relevant to that major field. These sub-areas are intended to cover the breadth of concepts of *structure, structural evolution, properties* (electrical, optical, magnetic, thermal, mechanical, flow/transport, surface; as appropriate to the major field), and *structure-property relationships*. A list of topics and reading material that the students can use in preparing for the exam in each area will be made available prior to the exam.

Students with a GPA of 3.5 or better are automatically eligible to take the exam. The department's Graduate Advisor will consult with the student's advisor and then either confer or deny eligibility to a student with a GPA of 3.2 or better. Students with a GPA less than 3.2 are ineligible but will have one chance to take the next scheduled Preliminary Exam provided they can increase their GPA to 3.2 and gain the consent of the Graduate Advisor and their research advisor.

In consultation with his/her advisor, the student proposes the three areas within the major in which he/she is to be examined. These areas should be submitted for approval to the Departmental Graduate Advisor at least one month prior to the date of the exam. A student whose intended research topic does not fit clearly within one of the established majors can petition to form a major from subject areas from two fields.

All students are required to acquire knowledge in two minor fields, different from the student's major(s). This requirement shall be satisfied by passing (with a grade of B+ or better) one course for each minor field from the Approved Courses for the Minor listed below. The minor field requirements must be satisfied by the end of the student's second year of study.

The Preliminary Examination for each major field is carried out on a single day each time the exam is offered. (The exam is normally offered twice per year, at the end of Spring quarter and the beginning of the Fall quarter.) Students beginning in the fall must take their Preliminary Examinations at the end of the Spring quarter of their first year. The student is examined individually by one faculty member in each of the three sub-areas within the major applicable to that student, with the examination in each area lasting about 20 minutes. All students taking the examination in a specific major area are asked the same set of questions, with the extent and depth of follow-up questions determined by the student's initial answers. A grade for the subject area is assigned to each student by the corresponding examiner. The questions are designed so that a passing grade in an area can be obtained with sound knowledge of the subject at the senior undergraduate level. However, students are expected to demonstrate a more advanced level of understanding—consistent with the first year of graduate studies—in at least one of the sub-areas within their major. That is, a student should pass all three areas, but performance better than a marginal "pass" in at least one of the major sub-areas is required for an overall "pass" in the major field. The students will be notified of the results of the exam on the following working day after the exam is taken.

Students shall have two opportunities to pass the Preliminary Examination. Students failing the exam must take all three sub-areas of their major again. The second exam must be taken without exception the next time the exam is offered. Students cannot take their qualifying examination until passing all of the requirements of the Preliminary Examination.

Approved Courses for the Minor:

MATRL 218	Introduction to Inorganic Materials (fulfills inorganic minor)
MATRL 221	Introduction to Structural Materials (fulfills structural minor)
MATRL 225	Introduction to Electronic Materials (fulfills electronic minor)
MATRL 271C	Properties of Macromolecules (fulfills macro/biomolecular minor)

Additional guidelines and reading lists will be provided in a separate booklet prior to the exam.

Qualifying Examination (Advancement to Candidacy)

Students must pass an oral qualifying examination where they must defend a written dissertation proposal based on original research and the strategy to carry the project to completion. The purpose of the exam is to assess whether the individual has acquired the requisite knowledge and critical thinking ability to elaborate a sound research plan for his/her topic of choice. Some preliminary research is required to elaborate a dissertation proposal, but the exam is not intended to evaluate a project that is well past the planning point. Hence, the examination must be taken before the beginning of the student's third year in residence, and preferably earlier. Successful completion of the preliminary examination is a pre-requisite.

The examination committee consists of five faculty with at least three having more than a 0% appointment in the Materials Department and at least one with no more than a 0% appointment in the Materials Department. One member of the committee, other than the advisor, is expected to serve as Chair of the qualifying exam committee. Members of the examination committee are nominated by the student and research advisor and must be approved by the candidate, advisor, and the Academic Affairs Committee.

The examinee must submit a formal written summary of his/her thesis project that summarizes the intended research problem, the research approach, results to date, and future directions. This proposal should be submitted to the examination committee at least two weeks before the examination. The format of the examination includes a 40-45 min presentation of the dissertation proposal by the student, during which time only questions of clarification will be allowed. The presentation will be followed by questions from the committee, which are expected to last 60-80 min. A decision of pass/no-pass will be rendered by the committee at the end of the examination. Students shall have two opportunities to pass the Qualifying Examination. Students failing the exam must retake the examination within six months. Upon passing the qualifying examination, the student advances to candidacy for the Ph.D. The examination committee typically becomes the dissertation committee. Students who fail the qualifying examination twice can not continue in the Ph.D. program.

The student should see the Graduate Program Assistant regarding the filing of necessary paperwork.

Ph.D. Dissertation

The candidate conducts original research under the supervision of the research advisor(s) and prepares a dissertation. The candidate and advisor(s) nominate a dissertation committee composed of the research advisor (as chair) and at least three other faculty; two with more than a 0% appointment in the Materials Department and one with no more than a 0% appointment in the Materials Department. These faculty members are normally selected from the Qualifying Examination committee members and must be approved by the Academic Affairs Committee. Students submit the final draft of the dissertation to the dissertation committee and the Department Chair four weeks prior to the intended date of the dissertation defense. The Department copy is available for general inspection. The committee ascertains the suitability of the draft. The candidate is then responsible for amendments to the dissertation, based on the committee recommendations. Once approved by the committee, permission is granted for the candidate to present a formal defense of the dissertation. A Guide to Filing Theses and Dissertations is available on the Graduate Division web page (http://www.graddiv.ucsb.edu/pubs/filingguide.shtml). In addition to the two copies which are filed in Davidson library (via the Graduate Division), as described in the above Filing Guide, a final copy must be submitted to the departmental collection. The department will bind an additional copy for the student. Both copies are to be provided by the student.

Dissertation Defense

At least four weeks prior to the oral defense, the final draft of the student's dissertation is to be submitted to the dissertation committee and to the Department, and at least one week prior to the defense, an *approved* final draft is submitted to the committee. The dissertation defense is a public seminar presented by the candidate on the dissertation research. The seminar must be attended by the dissertation committee. Any attendee at the defense can question the candidate. However, the Chair has the authority to terminate inappropriate questioning. The student should see the Graduate Program Assistant regarding the filing of all of the necessary paperwork.

M A T E R I A L S

2003-2004 Materials Department Course Outline

Proposed Course Listing for 2003-2004
****course offerings are subject to change****

	F03	W04	S04	Cross Listed Course
10 Materials in Society, The Stuff of Dreams		Petroff		
100A Structure and Properties I	Seshadri			
100B Structure and Properties II		Stemmer		
100C Fundamentals of Structural Evolution			Odette	
101 Introduction to Structure and Properties		Zok		
135 Biophysics and Biomolecular Materials		Safinya		Physics 135
160 Introduction to Polymer Science	Kramer			CH E 160
162A Quantum Description of Electronic Mtrls.	Bowers			ECE 162A
162B Fundamentals of the Solid State		DenBaars		ECE 162B
185 Materials in Engineering	Odette			ME 185
186 Manufacturing and Materials			Levi	ME 186
201 Thermodynamics and Phase Equilibria	Clarke			ME 262
202 Kinetic Processes in Materials		Levi		
204 Intro to Magnetism & Magnetic Materials			Spaldin	
205 Wide-Band Gap Materials and Devices		Nakamura		
206A Fundamentals of Electronic Solids I		Gossard		ECE 215A
207 Continuum Mechanics	Beltz			ME 219
209A Diffraction Methods	Speck			
209C Electron Microscopy		Speck		

	F03	W04	S04	Cross Listed Course
211A Engineering Quantum Mechanics I		Spaldin		ECE 211A
214 Statistical Mechanics		Fredrickson		Ch E 210B
215A Semiconductor Device Processing	Hu	Dagli		ECE 220A
215 B Semiconductor Device Processing			DenBaars	ECE 220B
215 C Semiconductor Device Processing			Nakamura	ECE 220C
217 Molecular Beam Epitaxy and Band Gap Engineering			Gossard	ECE 217
218 Introduction to Inorganic Materials		Sheshadri		CHEM 277
220 Mechanical Behavior of Materials		Evans		
221 Introduction to Structural Materials			Evans	
222A Colloids and Interfaces I		Israelachvili		CH E 222A
222B Colloids and Interfaces II		Zasadzinski		
224			Clarke	
225 Introduction to Electronic Materials	Spaldin			
230 Elasticity		McMeeking		ME 230
232 Plasticity			McMeeking	ME 232
234 Fracture Mechanics			McMeeking	ME 275
238B Rheology of Polymeric Liquids			Leal	CH E 238A
240 Finite Element Structural Analysis		McMeeking		ME 271
251A Ceramic Processing		Lange		CH E 219A
261 Composite Materials	Zok			ME 265
262 Structural Ceramics			Lange	

	F03	W04	S04	Cross Listed Course
266			Petroff	
271A Synthesis and Properties of Macromolecules	Deming			
271B Structure & Characterization of Complex Fluids		Pine		
271C Properties of Macromolecules			Kramer	
273 Experiments in Macromolecular Materials		Kramer		
274 Solid State Inorganic Materials			Stucky	CHEM 274
275 Polymer Physics		Pincus		
276A Biomolecular Materials I	Safinya			
276B Biomolecular Materials II			Safinya	
277 Synthesis of Biomolecular Materials		Deming		
280			Bazan	
286AA-ZZ Special Topics in Inorganic Materials				
287AA-ZZ Special Topics in Macromolecular Materials				
288 AA-ZZ Special Topics in Electronic Materials				
289 AA-ZZ Special Topics in Structural Materials				
290 Research Group Studies				
501 Teaching Assistant Practicum				
596 Directed Reading and Research				
598 Master's Thesis Research and Preparation				

	F03	W04	S04	Cross Listed Course
599 Ph.D. Dissertation Research and Preparation				

MATERIALS

Materials Department Course Description

COURSE DESCRIPTIONS

100A	**Structure and Properties I** An introduction to materials in modern technology. The internal structure of materials and its underlying principles: bonding, spatial organization of atoms and molecules, structural defects. Electrical, magnetic and optical properties of materials, and their relationship with structure.
100B	**Structure and Properties II** Mechanical properties of engineering materials and their relationship to bonding and structure. Elastic, flow, and fracture behavior; time dependent deformation and failure. Stiffening, strengthening, and toughening mechanisms. Piezoelectricity, magnetostriction and thermo-mechanical interactions in materials.
100C	**Fundamentals of Structural Evolution** An introduction to the thermodynamic and kinetic principles governing structural evolution in materials. Phase equilibria, diffusion and structural transformations. Metastable structures in materials. Self-assembling systems. Structural control through processing and/or imposed fields. Environmental effects on structure and properties.
101	**Introduction to the Structure and Properties of Materials** Introduction to the structure of engineering materials and its relationship with their mechanical properties. Structure of solids and defects. Concepts of microstructure and origins. Elastic, plastic flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanism.
135 (PHYS 135)	**Biophysics and Biomolecular Materials (3 units)** Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).
160 (CH E 160)	**Introduction to Polymer Science (3 units)** Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. The course is taught from a materials perspective and includes polymer thermodynamics, chain architecture, measurement and control of molecular weight as well as crystallization and glass transitions.

162A **(ECE 162A)**	**Quantum Description of Electronic Materials (4 Units)** Electrons as particles and waves, Schrodinger's equation and illustrative solutions. Tunneling, Atomic structure, the exclusion principle and the periodic table. Bonds, free electrons in metals, periodic potentials and energy bands.
162B **(ECE 162B)**	**Fundamentals of the Solid State (4 Units)** Crystal lattices and the structure of solids, with emphasis on semiconductors. Lattice vibrations, electronic states and energy bands. Electrical and thermal conduction. Dielectric and optical properties. Semiconductor devices: diffusion, p-n junctions and diode behavior.
ECE 162C	**Optoelectronic Materials and Devices (4 units)** Optical transitions in solids. Direct and indirect gap semiconductors. Luminescence. Excitons and photons. Fundamentals of optoelectronic devices: semiconductor lasers, LED's photoconductors, solar cells, photo diodes, and modulators. Photoemission. Integrated optics.
185 **(ME 185)**	**Materials in Engineering (3 units)** Introduction to the main families of materials and the principles behind their development, selection, and behavior. Discussion of the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. Emphasis on the relationship of properties to structure and processing.
186 **(ME 186)**	**Manufacturing and Materials (3 units)** Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.
201 **(ME 262)**	**Thermodynamics and Phase Equilibria (3 Units)** Advanced Thermodynamics with emphasis on phase equilibria, properties of solutions, and multicomponent systems.
202	**Kinetic Processes in Materials (3 Units)** Kinetics of transformations of materials with emphasis on first order phase transformations
203 **(CHEM 267)**	**Transition Metal Oxides (3 Units)** Introduction to transition metal oxides. Ligand field theory. Structural basis of magnetism.

204 **Introduction to Magnetism and Magnetic Materials (3 units)**
Review of basic magnetism, including magnetostatics, the quantum mechanical origins of magnetism, and types of magnetic materials. Theories of magnetism, and explanation of the properties of magnetic materials. Magnetic phenomena and their technological applications.

205 **Wide-Band Gap Materials and Devices (3 Units)**
Optical and electronic properties of GaN, ZnSe, SiC and Diamond based semiconductor materials. Theory and practical application of wide-band
gap materials in devices. Materials growth techniques of MOCVD, CVD and MBE will also be discussed. Applications of these materials in blue lasers, LEDS (UV, blue, green and white) emphasized.

206A (ECE 215A) **Fundamentals of Electronic Solids I (4 Units)**
Introduction into the physics of semiconductors, for beginning engineering graduate students. Crystal structures. Reciprocal lattice and crystal diffraction. Electrons in periodic structures. Energy and bands. Semiconductor electrons and probes, Fermi statistics.

206B (ECE 215B) **Fundamentals of Electronic Solids II (4 Units)**
Phonons, electron scattering, electronic transport, selected optical properties, heterostructures, effective mass, quantum wells, two-dimensional electron gas, quantum wires, deep levels, and crystal binding.

207 (ME 219) **Continuum Mechanics (3 Units)**
Matrices and tensors, stress deformation and flow, compatibility conditions, constitutive equations, field equations and boundary conditions in fluids and solids, applications in solid and fluid mechanics.

208 **Crystallography and Structure Determination (4 Units)**
Topics in structure determination: structure factors, integrated intensities, data collection, the phase problem, Patterson synthesis, direct methods, structure refinement, Debye-Waller factors, thermal diffuse scattering and extinction. Rietveld analysis of powder diffraction data. Synchrotron X-Rays, neutron diffraction, electron diffraction, non-crystalline materials.

209A **Diffraction Methods (3 Units)**

Diffraction theory: Fourier transformation, Schrodinger equation, Maxwell's equations, kinematical theory, Fresnel diffraction, Fraunhofer diffraction, scattering of X-rays, electrons and neutrons by isolated atoms and assemblies of atoms, pair correlation and radial distribution functions. Basic symmetry operations, point groups, space groups.

209B **X-Ray Diffraction (3 Units)**

This course will focus on modern diffraction techniques from crystalline materials. High resolution x-ray diffraction. Analysis of epitaxial layers. X-ray scattering theory. Simulation of x-ray rocking curves. Analysis of thin films and multiple layers. Triple-axis x-ray diffractometry. Topography. Synchotron techniques.

209C **Electron Microscopy (3 Units)**

Electron microscopy to study defect structures, elastic and inelastic scattering, kinematics theory of image contrast, bright and dark field imaging, two-beam conditions, contrast from imperfections, dynamical theory of diffraction and image contrast. Howie Whellan equations, dispersion surfaces.

211A (ECE 211A) **Engineering Quantum Mechanics I (4 Units)**

Wave-particle duality; bound states; uncertainty relations; expectation values and operators; variational principle; eigenfunction expansions; perturbation theory I. Treatment matches needs and background of ECE and materials students emphasizing solid state or quantum electronics.

211B (ECE 211B) **Engineering Quantum Mechanics II (4 Units)**

Continuation of Materials 211A; symmetry and degeneracy; electrons in crystals; angular momentum; perturbation theory II; transition probabilities; quantized fields and radiative transitions; magnetic fields; electron spin; indistinguishable particles.

213 (ECE 213) **Crystal Growth and Thin Film Epitaxy (3 Units)**

Nucleation and epitaxy: homogeneous and heterogeneous epitaxy. Growth mechanism, defect creation. Kinetics and thermodynamics of crystal growth for: liquid phase epitaxy, vapor phase epitaxy and molecular beam epitaxy of metals and semiconductors. (Normally offered in alternate years.)

214 **Statistical Thermodynamics (3 Units)**
(CH E 214)
Ensembles and statistical mechanical formulation of the laws of thermodynamics. Classical statistical mechanics; quantum statistics; translational, rotational, vibrational, and electronic partition functions. Chemical equilibria. Real gases and distribution functions: other interacting systems: liquids and solids: Monte Carlo simulations.

215A **Semiconductor Device Processing (4 Units)**
(ECE 220A)
Intensive theoretical and laboratory instruction in solid-state device and integrated circuit fabrication. Topics include: semiconductor materials properties and characterization, phase diagrams, diffusion, thermal oxidation, vacuum process, thin film deposition, scanning electron microscopy. Both gallium arsenide and silicon technologies are presented.

215 B-C **Semiconductor Device Processing (4-4 Units)**
(ECE 220B-C)
Continued theoretical and laboratory instruction in the fundamentals, the design, the fabrication, and the characterization of junction and field-effect devices. Topics will include bipolar characterization, design, fabrication, and testing. The laboratory effort initiated in Matrl 215A will be continued in these quarters.

216A **Defects in Materials (3 Units)**
(ECE 216A)
The nature point, line, and planar defects in crystalline solids. Dislocation basis for deformation behavior. Effect of different defects on electrical and optical properties of solids. Common defects in metals, semiconductors and ceramics. (Normally offered in alternate years.)

216B **Defects in Semiconductors (3 Units)**
(ECE 216B)
Structural and electronic properties of elementary defects in semiconductors. Point defects and impurity complexes. Deep levels. Dislocations and grain boundary electronic properties. Measurement techniques for radiative and non-radiative defect centers. (Normally offered in alternate years.)

217 **Molecular Beam Epitaxy and Band Gap Engineering (3 Units)**
(ECE 217)
Fundamentals and recent research developments in the growth and properties of thin crystalline films of electronic and optical materials by the process of molecular beam epitaxy. Artificially structured materials with quantized electron confinement and artificially engineered electronic band structure properties. (Normally offered in alternate years.)

218 **(Chem 277)** **Introduction to Inorganic Materials (3 Units)**
Structures of inorganic materials: close packing, linking of simple polyhedra. Factors that control structure: Ionic radii, covalency, ligand field effects, metal bonding, electron/atom ratios. Structure-property relationships in e.g. spinels, garnets, perovskites, rutiles, flourites, zeolites, B-aluminas, graphites, common inorganic glasses.

219 **Phase Transformations (3 Units)**
Introduction to the unifying concepts underlying phase transformation in metals, ceramics, polymers, and electronic materials. Includes the thermodynamics, kinetics, crystallography and microstructural characterization of displacive and diffusional transformations. Role of elastics, compositional, configurational, electrical, magnetic and gradient energy contributions.

220 **Mechanical Behavior of Materials (3 Units)**
Concepts of stress and strain. Deformation of metals, polymers and ceramics. Elasticity, viscoelasticity, plastic flow, and creep. Linear elastic fracture mechanics. Mechanisms of ductile and brittle fracture.

221 **Introduction to Structural Materials (3 Units)**
Introduction to structure-property relations in engineering materials, including polymers, metals, and ceramics. Elastic, plastic, and creep deformation. Fracture processes. Strengthening and toughening mechanisms.

222A **(CH E 222A)** **Colloids and Interfaces I (3 Units)**
Introduction to the various intermolecular interactions in solutions and in colloidal systems: Van der Waals, electrostatic, hydrophobic, solvation, H-bonding. Introduction to colloidal systems: particles, micelles, polymers, etc. Surfaces: wetting, contact angles, surface tension, etc.

222B **(CH E 222B)** **Colloids and Interfaces II (3 Units)**
Continuation of 222A. Interparticle interactions, coagulation, flocculation, DLVO theory, steric interactions, polymer coated surfaces, polymers in solution, viscosity in thin liquid films. Surfactant self-assembly: micelles, micro-emulsions, lamellar phases, etc. Surfactants on surfaces: Langmuir-Blodgett films, absorption, adhesion.

223A-B (Chem 203A-B; CH E 203A-B) **Combinatorial Methods in Chemistry and Chemical Engineering (3 Units)**
Foundation and methodologies of chemical, biological, and materials research and discovery using automated, high-speed synthesis and screening. Emphasis on the chemical, biochemical, physical, and mathematical fundamentals necessary for experimental design, synthesis, high-throughput screening, and analysis of combinatorial libraries.

224 **Optical and Luminescent Materials (3 Units)**
Description of the principles underlying the optical and luminescent behavior of materials illustrated with applications drawn from phosphors, optical fibers, optical memories and electro-optical components and immuno-assay techniques. Fundamental concepts of absorption and emission, and their relation to electronic structure and crystal properties.

225 **Introduction to Electronic Materials (3 Units)**
Basic quantum mechanics: wave functions and expectation values, free electrons, quantum wells, scattering and tunneling. Basic solid state physics: energy bands in solids, electronic and optical properties of metals and semiconductors. Devices: p-n junctions, transistors, light emitting diodes and lasers.

226 **Electrical and Optical Properties of Oxides (3 Units)**
Physical basis for ferroelasticity and piezoelectricity in ceramics. Point defects and doping effects of conductivity. Role of grain boundaries and variations in defect chemistry on electrical properties. Optical, non-linear and electro-optical effects and figures of merit. (Normally offered in alternate years.)

227 **Vapor Phase Epitaxy of Electronic Materials (3 Units)**
Electronic and optical properties of thin films grown by vapor phase transport techniques. Growth mechanisms, kinetics and thermodynamics of vapor phase epitaxy. Special emphasis on the process of metalorganic vapor phase epitaxy for optoelectronic materials and devices. (Normally offered in alternate years.)

228 **Computational Materials (3 Units)**
Basic computational techniques and their application to simulating the behavior of materials. Techniques include: finite difference methods, Monte Carlo, molecular dynamics, cellular automata, and simulated annealing. (Normally offered in alternate years.)

230
(ME 230)

Elasticity (3 Units)
Review of the field equations of elasticity. Energy principles and uniqueness theorems. Elementary problems in 1 and 2 dimensions. Stress functions, complex variable methods and potentials for 3-dimensional analysis. Fundamental solutions in 2 and 3 dimensions. Approximate methods.

232
(ME 232)

Plasticity (3 Units)
Plastic, creep and relaxation behavior of solids. Mechanisms of inelastically strained bodies, plastic stress-strain laws, and flow potentials. Torsion and bending of prismatic bars, expansion of thick spherical and cylindrical shells, plane plastic flow, slip line theory. Variational formulations, approximate methods.

234
(ME 275)

Fracture Mechanics (3 Units)
Analytic solutions of a stationary crack under static loading. Elastic and elastoplastic analysis. The J integral. Energy balance and crack growth. Criteria for crack initiation and growth. Dynamic crack propagation. Fatigue. The micromechanics of fracture.

237

Advanced Deformation and Fracture (3 Units)
Plastic flow in crystalline solids; strengthening mechanisms; creep deformation; creep maps; fracture modes; toughening mechanisms; subcritical cracking; fatigue; cavitation and rupture

238A-B
(CH E 238A-B)

Rheology of Polymeric Liquids (3-3 Units)
A fundamentally-based course focusing on: the microstructural and molecular basis of viscoelastic flow for complex fluids with a particular focus on polymeric liquids, liquid crystals and colloidal suspensions; experimental techniques and the analysis of viscoelastic flow phenomena.

239
(CH E 239)

Light Scattering in Complex Fluids (3 Units)
Principles of static and dynamic light scattering applied to complex fluids. Scattering of electromagnetic waves, the static and dynamic structure factors, and the analysis of multiple scattering.

240 **(ME 271)**	**Finite Element Structural Analysis (3 Units)** Definitions and basic element operations. Displacement approach in linear elasticity. Element formulation: direct methods and variational methods. Global analysis procedures: assemblage and solution. Plane stress and plane strain. Solids of revolution and general solids. Isoparametric representation and numerical integration. Computer implementation.
250	**Transport Phenomena in Materials Processing (3 Units)** Fundamental concepts and mathematical descriptions of mass and energy transport as pertinent to the synthesis, processing and application of materials. Focus on transport problems within solids and at their interfaces with fluids. Emphasis on inorganic materials, including semiconductors.
251A **(CH E 219A)**	**Ceramic Processing (3 Units)** Processing of ceramics: glass-ceramics, gelation and powder methods. Powder methods will be emphasized from powder manufacture through consolidation of shape, with introduction to densification. Colloidal routes to powder preparation and consolidation.
251B **(CH E 219B)**	**Densification and Microstructural Control (3 Units)** Mass transport and kinetic sintering theories. Thermodynamics of pore phase disappearance. Grain growth during densification. Effects of a liquid phase (liquid phase sintering). Effects of inert phases on densification. Effects of applied pressure. Control of grain growth after densification.
253	**Liquid Crystal Materials (4 Units)** Thermotropic and lyotropic liquid crystals (LC's). Classification and phase transitions. LC's in display technology. Laboratory experimentation using x-ray diffraction and polarized optical microscopy to characterize LC phases.
261 **(ME 265)**	**Composite Materials (3 Units)** Stress and strain relations in composites. Residual stresses. The fracture resistance of organic and inorganic matrix composites. Statistical aspects of fiber failure. Composite laminated and delamination cracks. Cumulative damage concepts. Interface properties. Design criteria. (Normally offered in alternate years.)

262 **(CH E 262)**	**Structural Ceramics (3 Units)** Ceramic processing methods. Flaws in ceramics. Fracture resistance and microstructure. Probabilistic design concepts. Non-destructive evaluation approaches. Reinforced ceramics. High temperature properties. Impact damage.
263	**Films and Multilayers (3 Units)** The development of stresses in thin films and its relaxation. Edge effects and discontinuities. Cracks in films and at interfaces. Delamination of residually stressed films. Cyclic behavior and ratcheting effects.
264	**Reliability and Degradation of Materials (3 Units)** Effects of service environment on properties of materials including oxidation, corrosion, thermal aging, radiation damage. Effects of property degradation on service life. (normally offered alternate years)
271 A	**Synthesis and Properties of Macromolecules (3 Units)** Basics of preparation of polymers and macromolecular assemblies, and characterization of large molecules and assemblies. Discussion of quantum mechanics of chemical structure, bonding, and reactivity. Elements of elasticity and viscoelasticity.
271B	**Structure and Characterization of Complex Fluids (3 Units** Structure, phase behavior, and phase transitions in complex fluids. Characterization techniques including x-ray and neutron scattering, and light and microscopy methods. Systems include colloidal and surfactant dispersions (e.g., polyballs, microemulsions, and micelles), polymeric solutions and biomolecular materials (e.g., lyotropic liquid crystals).
271C	**Properties of Macromolecules (3 Units)** Fundamentals of the properties of macromolecular solutions, melts, and solids. Viscosity, diffusion and light scattering from dilute solutions. Elements of macromolecular solid state structure. Thermal properties and processes. Mechanical and transport properties. Introduction to electrical and optical properties of macromolecules.
273	**Experiments in Macromolecular Materials (3 Units)** Experiments using x-ray and light scattering, optical and electron microscopy. Crystalline, quasi-crystalline and amorphous materials. Solid, solution and colloidal samples.

274
(Chem 274)

Solid State Inorganic Materials (3 Units)
An introductory course describing the synthesis, physical characterization, structure, electronic properties, and uses of solid state materials

275

Polymer Physics (3 Units)
Polymer dynamics of solutions and melts. Spinodal decomposition, gels, copolymers, and blends. Non-equilibrium behavior.

276A

Biomolecular Materials I: Structure and Function (3 Units)
Survey of classes of biomolecules (lipids, carbohydrates, proteins, nucleic acids). Structure and function of molecular machines (enzymes for biosynthesis, motors, pumps).

276B

Biomolecular Materials II: Applications (3 Units)
Interactions and self assembly in biomolecular materials. Chemical and drug delivery systems. Tissue engineering. Protein synthesis using recombinant nucleic acid methods: advanced materials development. Nonvial gene therapy.

277

Synthesis of Biomolecular Materials (3 Units)
Methods of preparation of biopolymers and biomolecular assemblies. Uses of biological techniques to engineer biomaterials. Uses of chemical techniques to prepare biological molecules as well as artificial biomimetic materials. Comparison of biological, chemical and mixed syntheses for different applications

278

Interactions in Biomolecular Complexes (3 Units)
Theory of coulombic interactions of biopolymers, lipid membranes, and their complexes. Mean field theories, fluctuation and correlation effects

279

X-Ray, Electron, Neutron and Light Scattering (3 Units)
The use of diffraction and scattering techniques for elucidating the structure, microstructure and defects in materials at different length scales. Both the formal basis and the underlying concepts that span the application to different classes of materials are described.

282 (Chem 221) — **Transitions Metal Catalyzed Polymerization (3 Units)**
Examination of strategies for controlling molecular weight, chain distribution, sequence, end groups and stereochemistry. Discussion of the influence of these variables over structure and properties. Tacticity, control, Ziegler-Natta catalysis, living polymerizations, stereoselective and enantioselective polymerizations, secondary and tertiary structures, polymer assemblies, and biological polymerizations.

284 (Chem 285) — **Synthetic Chemistry of Macromolecules (3 Units)**
Molecular architecture and classification of macromolecules. Different methods of the preparation of polymers: free radical polymerization, ionic polymerization, condensation polymerization and coordination polymerization. Bulk, solution and emulsion polymerization. Principles of copolymerization, block copolymerization, grafting, network formation, chemical reactions on polymers.

285 — **Structure and Properties of Interfaces (3 Units)**
Homophase and heterophase interfaces. Dichromatic pattern of interfaces (group theoretical description). Geometrical models of interfaces. Relaxations at interfaces and atomic structure, energies of interfaces. Bonding across interfaces. Thermodynamics and wetting of interfaces. Properties of interfaces such as diffusion, segregation and fracture resistance.

286AA-ZZ — **Special Topics in Inorganic Materials**
This course will be offered on an irregular basis and will include in-depth discussions of advanced topics in inorganic materials.

287 AA-ZZ — **Special Topics in Macromolecular Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in macromolecular materials.

288 AA-ZZ — **Special Topics in Electronic Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in electronic materials.

289 AA-ZZ — **Special Topics in Structural Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in structural materials.

290 — **Research Group Studies (1-3 Units)**
Students or instructors present recently published papers and/or results relevant to their own research.

501 **Teaching Assistant Practicum (1-4 Units)**
Practical experience in the various activities associated with teaching including: lecturing, supervision of laboratories and discussion sections, preparation and grading of homework and exams.

596 **Directed Reading and Research (2-4 Units)**
Individual tutorial. Instructor is usually student's major professor. The department chair must approve a written proposal for each tutorial.

598 **Master's Thesis Research and Preparation (1-12 Units)**
For research underlying the thesis and writing of the thesis.

599 **Ph.D. Dissertation Research and Preparation (1-12 Units)**
Research and preparation of the dissertation.

MATERIALS

Appendix

Computing Facilities

Resources Available in the Department

In addition to computer workstations in all student offices, there is one Macintosh, two NT, two Linux and six Silcon Graphics UNIX workstations available in the Engineering Computing Infrastructure (ECI) III Computer Lab located in Engineering III, room 111 for student and other research use. In addition, there are three other open access ECI computer labs in the College. (For further information concerning computer use in the College, including the location of the ECI computer labs, please visit the ECI's home page, (http://www.engineering.ucsb.edu/~eci-web.).

A College of Engineering account, available to all Materials personnel, is necessary to use the workstations. A College of Engineering Computing Account Request form, available from the Personnel Assistant in the Materials Accounting Office (Engineering III, room 103) should be filled out, signed, and taken to the Engineering Computing Infrastructure (ECI) office in Engineering I, room 3110. The account will be active within one to two days. Once active, the account will provide access to the workstations and provide email access. Moreover, anyone that has an account can also Telnet to any of the UNIX machines in the ECI I, II, and III Labs using a Secure Telnet Application. The account will expire three months after the student's last date of registration.

Remote Access to Campus

To access any of the ECI lab workstations, dial in to campus by using the appropriate phone numbers listed:

893-3000 (Up to 56K V.90*)
2 Hour Time Limit, Supports connection to any campus host using PPP or telnet.
893-8400 (Up to 56K V.90*)

30 Minute Time Limit, Supports connection to any campus host using PPP or telnet.
For more information on the modems provided by Communications Services (http://www.commserv.ucsb.edu/), you can visit their web site devoted to accessing UCSB via the Modem Pools (http://www.commserv.ucsb.edu/hpage/hot/remote.htm).

Materials Department Computer Consultants

The Department employs a part-time system administrator, Mike Edwards, and a full-time computer consultant, Budd Jameison to maintain computers and answer any questions about the computing services. For assistance, you can email mats-help@engineering.ucsb.edu.

Internet

Materials On-Line Resources
The Materials Department Web Site (www.materials.ucsb.edu) is a valuable source of departmental and university information. At the web site, you will find:

- Quarterly Schedule of Materials Courses
- Listings of Materials Personnel (faculty, staff, other students) with email addresses
- Links to Faculty web pages
- List of Available Facilities within the department
- List of Related Research Centers and Groups (with links to their web pages)
- Health & Safety Information (including the Department Emergency Plan, Lab Safety Manuals, and links to important MSDS information and EH&S sites)
- Travel Policies and Procedures Manual

The departmental page also provides various links to other university web sites:

- UCSB's Home Page
- the UCSB General Catalog
- Davidson Library
- Office of the Registrar
- Counseling and Career Services
- Graduate Division (including the Filing Guide for Theses and Dissertations)
- College of Engineering

Creating Your Own Web Page

All Materials students are encouraged to create a web page. Designing a web page does not have to be difficult. By learning a small amount of HTML or by using a web-authoring program, such as Adobe PageMill™, Netscape Navigator Gold™, or Microsoft Word 98™, you can set up your own web site files.

On-Line Web-Authoring Tutorials

One of the best resources for HTML and Web Design assistance is the World Wide Web itself. By searching under "HTML,""HTML Guide," etc. in a search engine, you can find almost everything anybody would ever want to know about web design. Below are a few sites that people have found helpful in the past:

- *Max's Place: HTML Tutorial :*http://www.ic.ucsb.edu/~max/tutorials/htmlintro.html
- *Bare Bones:* http://werbach.com/barebones/
- *National Center for Supercomputing Applications (NCSA) "A Beginner's Guide to HTML":* http://www.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimer.html
- *WWW Help Page:* http://werbach.com/web/wwwhelp.html#general
- *RGB Color Chart:* http://www.phoenix.net/~jacobson/rgb.html

- *Web Monkey:* http://www.hotwired.com/webmonkey/frontdoor/index.html?tw=webmonkey