



UC SANTA BARBARA
engineering



**FIVE YEAR COMBINED
BS-ENGINEERING / MS-MATERIALS
PROGRAM**

Revised Fall 2014

BS ENGINEERING/MS MATERIALS PROGRAM

CONTACT INFORMATION

Robert Garcia	COE Undergraduate Office	1006 Engr I	893-4153	robge@engineering.ucsb.edu
Jocelyn Guzman	Materials Dept. Graduate Office	1355A Engr II	893-4601	academic@engineering.ucsb.edu
Prof. Chris Palmstrom	Advisor for ECE students	1231A Engr II	893-2686	cpalmstrom@ece.ucsb.edu
Prof. Rachel Segalman	Acting Advisor for ChE students	3341 Engr II	893-3709	segalman@engineering.ucsb.edu
Prof. Carlos Levi	Program Coordinator and Advisor for ME students	1361D Engr II	893-2381	levic@engineering.ucsb.edu

Important: You must notify the Undergraduate Engineering Office and the Materials Department Graduate Office of your interest in the program before the start of the Spring Quarter of your Sophomore year, and arrange a meeting with the BS/MS Program Advisor for your Engineering Major Department on the quarter before you achieve Junior status to start planning your academic program. Students who do not comply with this requirement will find it difficult to join the program later on.

ABOUT THE PROGRAM

Why is knowledge of Materials important to Engineers?

- Materials are the substances of which things are made and, hence, their properties are critical to the performance of the components and systems constituted by them.
- From an Engineering perspective, *materials allow the embodiment of ideas to solve societal problems and to enhance our lives*. Indeed, almost every aspect of modern life is touched by a technology made possible by advances in materials. For example, it is difficult to envision the revolution in high speed computing and telecommunications without semiconductors and optical fibers, or the modern jet engine without high temperature superalloys, or advanced CAT scanners without superconducting magnets and ceramic scintillators, etc.
- Materials are often the enabling element of technological progress in all major industries in which engineers find employment, e.g. electronics, communications and information, biotechnology, aerospace, energy, transportation, environmental control, food processing, etc. As such, knowledge of materials has always been an asset for the practicing engineer and is likely to become even more important for professional success as the pace of technological change increases.
- The study of materials is predicated on the relationship between the *properties* of a material, which determine its *performance* in service, and its *internal structure*, i.e. the way in which the material is “put together”. In turn, the structure may be modified by changes in the chemical composition and the processing conditions, allowing the engineer to tailor the material for specific performance goals. Materials is a dynamic and eminently interdisciplinary field, with strong elements of both Science and Engineering, which provides understanding of why materials behave the way they do and thus enables engineers to better harness their potential in developing new technologies.

Is this program for you?

- This program is designed for students who wish to enhance their undergraduate education in one of the classical engineering disciplines by adding a strong knowledge base in the understanding of materials behavior, of their synthesis and processing, and of their applications in modern technology.
- The program allows outstanding students to concurrently pursue a Bachelor of Science degree in Chemical, Electrical, or Mechanical Engineering, and a Master of Science degree in Materials, and to complete graduation requirements for both degrees within 5 years. (See appendix for timelines and worksheets for each discipline.)
- The graduates of this program retain the breadth and flexibility inherent in the mainstream Engineering disciplines while their specialized knowledge of engineering materials will give them a competitive edge in the high technology industry.
- The program capitalizes on the emergence of UCSB as an internationally renowned institution in Materials research and education. The students involved will interact with faculty working at the cutting edge of technology in a broad range of modern materials, benefiting from their advice and expertise in areas critical to future industrial development.

ADMISSION PROCESS

The admissions process for the BS/MS program begins in the Spring quarter of the Sophomore year. At that time interested students must inform the Undergraduate Office in the College of Engineering and the Materials Graduate Office of their intention to pursue the Materials BS/MS program and consult with them about admission procedures and the structure of the program. (An information session for sophomores would typically be planned each year. Please consult the Materials Department Graduate Program Assistant for details.)

Prior to the start of their Junior year (or in the quarter when the student achieves Junior status), candidates should arrange for a meeting with one of the Materials Department's BS/MS advisors (below) to discuss their interests, academic goals and program requirements:

Chemical Engineering students Professor Edward Kramer
Electrical Engineering students Professor Chris Palmstrøm
Mechanical Engineering students Professor Carlos Levi

The BS/MS advisors help students plan their Junior and Senior year studies, in coordination with the student's own departmental B.S. program advisor, and also assist them during the application process for the program. In preparing their academic plan, all students interested in this program must plan on taking Matrl 100ABC during the junior year (no exceptions).

Applicants must meet the following requirements in order to qualify for admission:

- A minimum overall GPA of 3.2 at the end of the Junior year, with a 3.5 minimum GPA in Engineering courses, and a B minimum in each of the undergraduate Materials core courses (Matrl 100A, Matrl 100B and Matrl 100C);
- A GRE score with a minimum of 85% in the Quantitative portion and performance in the verbal and writing sections comparable to the Materials Department entry class in the previous academic year. GRE scores may be supplied after the application is submitted, but no later than August 1st prior to the beginning of Fall quarter of the applicant's Senior year, to allow the admissions committee enough time to evaluate the application.

While some exceptions might be made for special circumstances, students must realize that they will be taking courses with Ph.D. oriented students from a very competitive pool in the graduate part of the program, so they must be able to perform academically well in that environment.

The student must submit a formal application for admission to the graduate part of the BS/MS program in the Spring quarter of the Junior year. For this, the student must submit:

- A UCSB Graduate Application (electronic version at www.graddiv.ucsb.edu). This includes the statement of purpose and personal statement forms. You do not need to pay the fee. Please email academic@engineering.ucsb.edu to notify us that your application is complete.
- Two official transcripts from all post-secondary institutions attended,
- A copy of the approved undergraduate elective form, which the student filed with his/her home undergraduate department,
- Three letters of recommendation from people able to judge the potential of the student for graduate studies. These people should ideally be faculty at UCSB or other higher education institutions who are familiar with the student's academic performance.
- Official GRE scores

IMPLEMENTATION OF THE PROGRAM

Applicants will be notified of an admissions decision before the start of the Fall quarter of the senior year. This is necessary for the student to be able to take graduate courses in the first quarter of the senior year and receive credit for them toward the MS degree. Upon admission to the program, the student must select an emphasis (Electronic, Inorganic, Macro-/Bio-molecular or Structural) and an MS advisor within the Materials Department (usually different from the BS/MS advisors listed above). The MS advisor will help the student prepare his/her MS study plan and the engineering report required for graduation (see below).

All students in the BS/MS program are required to prepare an MS study plan before the end of the Fall quarter of their senior year. They should submit this plan together with their undergraduate departmental elective form first to the Materials Graduate Office for approval of the MS portion, and subsequently to the College of Engineering Undergraduate Office for final approval of the undergraduate elective form. These approvals are required before a BS/MS student is eligible for graduate status (i.e. before he/she completes 180 units).

In preparation for the Materials Graduate coursework, all BS/MS students must take Matrl 100A, B and C. (The Matrl 101 requirement for students in the Chemical and Mechanical Engineering B.S. programs will be waived if the student has completed the 100A,B,C series. Typically the units of 100B will be taken toward satisfying the 101 unit requirement.) In addition, students must take a minimum of 6 units of approved undergraduate elective courses from the list in Table 2. Students will be able to include on their undergraduate elective forms the Matrl 100 courses which are not required for the curriculum in their major (no credit given for both 101 and 100B) as well as the undergraduate electives selected from the list in Table 2 in order to satisfy the requirements of their individual curricula. (BS/MS students are allowed to take Materials undergraduate elective courses outside the approved departmental elective list for their tracks/emphases, with prior approval from their BS/MS advisor and their undergraduate departmental advisor.

MS students within this program are also allowed to take courses outside their chosen areas of emphasis (Electronic, inorganic, Macro/Biomolecular or Structural) with prior approval of their MS advisor and the departmental Materials Graduate Advisor. An MS Student can petition to take more advanced elective courses outside this list, with prior approval of his/her MS advisor.) BS/MS students must also take during their senior year at least one graduate Materials course per quarter towards the MS requirements from the list of graduate elective courses in Table 3. All students must plan on taking Matrl200A in the first quarter of the fifth year of the program. Matrl 200B and 200C are not required for BS/MS students, but could be taken as electives.

The final stage in the admission process is the advancement to graduate status. This change in status must happen prior to the beginning of the Fall quarter of the fifth year in order to satisfy the minimum residency requirements (3 quarters) of the Graduate Division. BS/MS students are therefore advised to change from undergraduate to graduate status as soon as they complete 180 units of coursework. The Undergraduate Office in the College of Engineering will inform the BS/MS candidates when they are eligible for change of status. Once a BS/MS student reaches graduate status, he/she can begin to take the rest of the graduate unit requirements. Students should be aware that the change in status will prompt the registrar to charge Graduate fees for courses taken during this time.

Students in this program must satisfy the Plan 2 requirements for the MS degree in the Materials section of the UCSB catalog. They must complete 42 units of graduate coursework, including at least 27 units of approved 200 level courses (200-289), at most 6 units of approved advanced undergraduate elective courses (Table 3) not already used for credit toward a previous degree, 3 units of seminars (Matr. 290) and at least 3 but no more than 6 units of independent studies (Matr 596). Students in the BS/MS program are neither required nor eligible to be teaching assistants, and thus are not eligible to receive credit for teaching assistant practicum (Matr 501).

The last requirement for all BS/MS students will be a final report based on work done as part of the independent studies unit requirement (3-6 units of Matr 596). A committee of two faculty members must approve the report. One of them must be the person who supervised the student in the 596 units (typically the student individual MS advisor). At least one of the faculty members evaluating the report must have a majority appointment in the Materials Department.

Note: In addition to fulfilling the requirements of the BS/MS program discussed above, students must ensure that they follow all the requirements of their individual undergraduate curricula for the Bachelor of Science in Chemical, Electrical or Mechanical Engineering. Tables are provided in the Appendix to help students in each curriculum understand how they can plan their BS/MS program to satisfy both the BS and the MS requirements within five years. At the end of a BS/MS student's senior year he/she has the option of filling out a BS graduation form and leaving the program with a BS degree, assuming all requirements for the BS have been met.

TABLE 1. TIMELINE FOR THE BS-ENGINEERING/MS-MATERIALS PROGRAM

Year:	Summary of Events:
Sophomore	Spring quarter: Notification to Undergraduate Office in the College of Engineering of student's interest in BS/MS program Meetings with the Materials Department Graduate Program Coordinator and appropriate faculty BS/MS advisor
Junior	Fall: Matr 100A; Winter: Matr 100B; Spring: Matr 100C Spring: Submission of application for admission to the BS/MS Program
Senior	Admission to program before beginning of Fall quarter. At most 6 units of approved undergraduate electives (Table II). For the most part, these electives can be taken while simultaneously fulfilling the student's undergraduate department's requirements. One Graduate course each quarter Change to graduate status before Fall quarter of the fifth year
Graduate	Remaining Undergraduate Courses, if any Matr 200A (Fall) plus remaining Graduate Electives Graduate Seminar, Matr 290 (3 units, one unit per quarter) Independent Studies, Matr 596 (3-6 units) Deliver Engineering Report based on Independent Studies by Spring.

APPENDIX A

APPROVED COURSES

TABLE II. APPROVED UNDERGRADUATE COURSES

Fall	U	Winter	U	Spring	U
Undergraduate Core					
MATRL 100A Structure & Properties I	3	MATRL 100B Structure & Properties II	3	Matrl 100C Structural Evolution	3
Undergraduate Electives					
CH E 102 Biomaterials and Biosurfaces	3	Phys/MATRL 135 Biophysics and Biomolecular Materials	3		3
CH E 121 Colloids and Biosurfaces	3	MATRL/CH E 160 Introduction to Polymer Science	3		
ECE/MATRL 162A* Quantum Description of Electronic Materials	4	ECE/MATRL 162B Fundamentals of the Solid State	4	ECE 162C Optoelectronic Materials and Devices	4
				ME 141B: MEMS Semiconductor Processing and Device Characterization	4
ME 167 Structural Analysis	3			ME 166 Advanced Strength of Materials	3
ME/MATRL 185 Materials in Engineering	3	ME/MATRL 186 Matrls. and Manufacturing	3	<i>ME 106B Mechanics, Materials and Structural Laboratory</i>	3

Any of the courses listed above may be taken by BS/MS candidates in any department to satisfy their undergraduate technical/departmental elective requirements with prior approval of the departmental undergraduate advisor.

Please check with individual departments as course scheduling may change from year to year and some courses may not be offered every year.

* Note this course is typically a background course for the Electronic/Photonic Materials graduate sequence (see next table).

TABLE III. APPROVED GRADUATE COURSES

Fall	U	Winter	U	Spring	U
Departmental Core and General Courses					
MATRL 200A Thermodynamic Foundation of Materials	4	MATRL 200B Electronic and Atomic Structure of Materials	4	Matrl 200C Structural Evolution in Materials	4
<i>MATRL 289G: Phase Stability and Microstructure Evolution</i>	3	MATRL 214: Advanced Topics in Equilibrium Statistical Mechanics	3		
MATRL 209A Crystallography and Diffraction Fundamentals	3	MATRL 209B: X-Ray Diffraction II	3	MATRL 209C: Electron Microscopy	3
<i>MATRL 228: Computational Materials</i>	3	MATRL 219: Phase Transformations	3		
<i>MATRL 253: Liquid Crystal Materials</i>	4	MATRL 222A Colloids and Interfaces I	3	<i>MATRL 222B Colloids and Interfaces II</i>	3
Electronic Materials					
MATRL 162A Quantum Description of Electronic Materials	4	MATRL 206A Fundamentals of Electronic Solids I	4	MATRL 206B Fundamentals of Electronic Solids II	4
		MATRL 211A Engineering Quantum Mechanics I	4	MATRL 211B Engineering Quantum Mechanics II	4
MATRL 215A Semiconductor Device Processing I	4	MATRL 215B Semiconductor Device Processing II	4	MATRL 215C Semiconductor Device Processing III	4
MATRL 205: Wide Band Gap Materials and Devices	3	MATRL 227: Metal-Organic Chemical Vapor Deposition	3	MATRL 217: Molecular Beam Epitaxy and Band Bap Engineering	3
<i>MATRL 216 Defects in Semiconductors</i>	3	<i>MATRL 267: Confined Electrons and Photons in Semiconductor Structures</i>	3		
Inorganic Materials					
		MATRL 218: Introduction to Inorganic Materials	3	MATRL 204 Introduction to Magnetism and Magnetic Materials	3
<i>MATRL 203 Transition Metal Oxides</i>	3	<i>MATRL 284: Solid State Inorganic Materials</i>	3	<i>MATRL 251: Processing of Inorganic Materials</i>	3

<i>MATRL 265 Nanophase and Nanoparticulate Materials</i>	3	<i>MATRL 224: Optical and Luminescent Materials</i>	3	<i>MATRL 226: Electrical and Functional Crystals and Ceramics</i>	3
Macromolecular and Biomolecular Materials					
MATRL 271A Synthesis and Properties of Macromolecules	3	MATRL 271B: Structure and Characterization of Complex Fluids	3	MATRL 271C Properties of Macromolecules	3
MATRL 273 Experiments in Macromolecular Materials	3	MATRL 284: Synthetic Chemistry of Macromolecules	3	<i>MATRL 277: Synthesis of Biomolecular Materials</i>	3
<i>MATRL 276A: Biomolecular Materials I: Structure and Function</i>	3	<i>MATRL 276B: Biomolecular Materials II: Applications</i>	3	<i>MATRL 278: Interactions in Biomolecular Complexes</i>	3
<i>MATRL 280A: Synthesis and Electronic Structures of Conjugated Polymers</i>	3	<i>MATRL 280B: Organic Electronic Devices</i>	3	<i>MATRL280C: Fabrication and Measurement of Devices with Soft Matter</i>	3
Structural Materials					
MATRL 207 Mechanics of Materials	3	MATRL 220 Mechanical Behavior of Materials	3	MATRL 234: Fracture Mechanics	3
<i>MATRL 230: Elasticity and Plasticity</i>	3			MATRL 240: Finite Element Structural Analysis	3
<i>MATRL 261: Composite Materials</i>	3			<i>MATRL 263: Thin Films and Multilayers</i>	3

Notes:

- Students are expected to design a program of study based on the above courses (Tables II and III) with assistance from their faculty advisor.
- **Courses in bold are departmental or area core for the Ph.D.** Courses in normal font are electives offered every year. *Courses in italic are electives offered every other year.* (Course schedules and frequency are subject to change.).
- Some introductory graduate courses will not be available for credit to students who have taken undergraduate courses covering similar topics, e.g. students cannot get credit toward the MS for ME166 or ME 162 if they are taking Matrl207

APPENDIX B:
SAMPLE SCHEDULES
BY UNDERGRADUATE MAJOR

BS-CHEMICAL ENGINEERING/MS-MATERIALS

Junior Year (47 units)					
FALL	Units	WINTER	Units	SPRING	Units
CH E 119	1	CHEM 113B	4	CHEM 113C	4
CH E 120A	4	CH E 120B	3	CH E 120C	3
CH E 128	3			CH E 140A	3
CH E 132A	4	CH E 132C	3	CH E 180A	3
		GE Elective	3		
MATRL 100A[†]	3	MATRL 100B	3	MATRL 100C[†]	3
Total:	15		16		16
Senior Year (50 units)					
FALL	Units	WINTER	Units	SPRING	Units
CH E 132B	3	CH E 180B	3	CH E 184B	3
CH E 140B	3	CH E 184A	3		
CH E 152A	4	Tech. or Free El.	4	Tech. or Free El.	7
CH E 170	3	GE Elective	4	GE Elective	4
Matrl Grad. Elec.	3	Matrl Grad. Elec.	3	Matrl Grad. Elec.	3
TOTAL	16		17		17
Graduate Year (33 units)					
FALL	Units	WINTER	Units	SPRING	Units
MATRL 200A	4	MATRL 596	3*	MATRL 596	3*
Matrl Grad. Elec.	6-8	Matrl Grad. Elec.	6-7	Matrl Grad. Elec.	6-7
MATRL 290	1	MATRL 290	1	MATRL 290	1
TOTAL	11-13		10-11		10-11

* Please Note: Students must take at least 3, but no more than 6 units of Matrl 596.

† Matrl 100A and 100C count toward the undergraduate technical elective requirements.

6 additional units of undergraduate technical electives must have Materials content.

BS-ELECTRICAL ENGINEERING/MS-MATERIALS

Junior Year (48 units)					
FALL	Units	WINTER	Units	SPRING	Units
ECE 130A	4	ECE 130B	4	ECE 139	4
ECE 132	4	ECE 137A	4	ECE 137B	4
ECE 134	4	GE / Free UG Elec.	4	GE / Free UG Elec.	7
MATRL 100A[†]	3	MATRL 100B[†]	3	MATRL 100C[†]	3
Total:	15		15		18
Senior Year (51 units)					
FALL	Units	WINTER	Units	SPRING	Units
ECE 152A	5			ENGR 101	3
ECE Electives	4	ECE Elec.	7	ECE Elec.	4
GE / Free UG Elec.	4	GE / Free UG Elec.	8	GE / Free UG Elec.	7
Matrl Grad Elec.	3	Matrl Grad Elec.	3	Matrl Grad Elec.	3
Total	16		18		17
Graduate Year (41 units)					
FALL	Units	WINTER	Units	SPRING	Units
MATRL 200A	4	MATRL 596	3*	MATRL 596	3*
Matrl Grad. Elec.	6-8	Matrl Grad. Elec.	6-7	Matrl Grad. Elec.	6-7
MATRL 290	1	MATRL 290	1	MATRL 290	1
		ECE Elective	4	ECE Elective	4
TOTAL	11-13		14-15		14-15

* Please Note: Students must take at least 3, but no more than 6 units of Matrl 596.

† Matrl 100A, 100B and 100C count toward the undergraduate departmental elective requirements.
3 additional units of undergraduate technical electives must have Materials content.

BS-MECHANICAL ENGINEERING/MS-MATERIALS

Junior Year (50 units)					
FALL	Units	WINTER	Units	SPRING	Units
ME 104	3	ME 163	3	ME 105	4
ME 140A	3	GE / Free UG Elec.	4	ME 153	3
ME 151A	4	ME 151B	4	ME 154	3
ME 152A	4	ME 152B	3	ME 155A	3
MATRL 100A[†]	3	MATRL 100B	3	MATRL 100C[†]	3
Total:	17		17		16
Senior Year (47 units)					
FALL	Units	WINTER	Units	SPRING	Units
ME 151C	3				
ME 156A	3	ME 156B	3	UG Dept. Elec.	3
ME 189A	2	ME 189B	2	ME 189C	2
GE / Free UG Elec.	4	GE / Free UG Elec.	8	GE / Free UG Elec.	8
Matrl Grad Elec.	3	Matrl Grad Elec.	3	Matrl Grad Elec.	3
Total	18		16		16
Graduate Year (39 units)					
FALL	Units	WINTER	Units	SPRING	Units
MATRL 200A	4	MATRL 596	3*	MATRL 596	3*
Matrl Grad. Elec.	6-8	Matrl Grad. Elec.	6-7	Matrl Grad. Elec.	6-7
MATRL 290	1	MATRL 290	1	MATRL 290	1
		UG Dept. Elec.	3	UG Dept. Elec.	3
TOTAL	11-13		13-14		13-14

* Please Note: Students must take at least 3, but no more than 6 units of Matrl 596.

† Matrl 100A and 100C count toward the undergraduate departmental elective requirements.
6 additional units of undergraduate technical electives must have Materials content.

MATERIALS DEPARTMENT

MS Study Plan 2 for BS/MS Students

Name: _____

Last

First

MI

Email address: _____ Phone number: _____

Undergraduate Department: _____

Graduate Field of Study: _____

Program Plan Approval:

Faculty MS Advisor _____

Department Graduate Advisor _____

~~~~~  
**Graduate Core Course:**

**Matrl 200A (4 units):** \_\_\_\_\_

**Graduate Electives (27 units):**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Matrl 290 (3 units):** \_\_\_\_\_

**Matrl 596 (3-6 units):** \_\_\_\_\_

**Total Graduate Units:** \_\_\_\_\_

***Report Committee:***

\_\_\_\_\_  
(Chair)

\_\_\_\_\_

*For departmental use only.*

Date Residency Requirement Satisfied \_\_\_\_\_

Date UG Requirements Completed: \_\_\_\_\_

Entrance Date: \_\_\_\_\_

Change to MS Status Date: \_\_\_\_\_

Date Graduate Requirements Fulfilled: \_\_\_\_\_

## **Acknowledgment of Having Read BS/MS Student Manual**

(Print this page, sign it after reading the manual and turn it in to the Graduate Program Assistant)

I, \_\_\_\_\_ acknowledge that I have carefully read and understood the contents of the BS/MS Student Manual for the Materials Department (Edition Fall 2014). I understand my first point of contact for any questions regarding the BS/MS Manual or the BS/MS Materials Program is the Graduate Program Assistant\* in the Materials Department, who may refer me to the Graduate Advisor\*\* in the Materials Department.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

After having read and signed this page, it must be turned into the Graduate Program Assistant in the Materials Department by the end of the Fall Quarter of your Senior Year.

\* The current Graduate Program Assistant is Ms. Jocelyn Guzman

\*\* The current Graduate Advisor is Prof. Carlos G. Levi