University of California, Merced – Academic Program Learning Outcomes

UNDERGRADUATE PROGRAMS

School of Engineering - Majors:

Bioengineering

- Graduates will demonstrate an understanding of biology and physiology.
- Graduates will demonstrate the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve problems at the interface of engineering and biology.
- Graduates will demonstrate the ability to make measurements on, and interpret data from, living systems.
- Graduates will demonstrate the ability to address problems associated with the interaction between living and non-living materials and systems.
- Graduates will demonstrate professional and ethical responsibility.

Computer Science and Engineering

Upon graduation, we expect our students to demonstrate:

a) An ability to apply knowledge of computing and mathematics appropriate to the discipline;
(b) An ability to analyze a problem and identify the computing requirements appropriate for its solution;
(c) An ability to design, implement, and evaluate a computer-based system, process, component, or program
to meet desired needs;
(d) An ability to function effectively as a member of a team in order to accomplish a common goal;
(e) An understanding of professional, ethical, legal, security, and social issues and responsibilities;
(f) An ability to communicate effectively with a range of audiences;
(g) An ability to analyze the local and global impact of computing on individuals, organizations, and society;
(h) Recognition of the need for and an ability to engage in continuing professional development;
(i) An ability to use current techniques, skills, and tools necessary for computing practice;
(j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory to
the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices;

(k) An ability to apply design and development principles in the construction of software systems of varying complexity.

Environmental Engineering

The EnvE program has six learning outcomes which characterize an EnvE graduate and what he/she will be enabled to accomplish following graduation:

1. EnvE graduates will have gained a strong foundation in basic mathematics, science, social science, humanities and arts, along with engineering principles, enabling active engagement as citizens in their communities.
2. EnvE graduates will be adept at applying critical thinking, problem solving, engineering principles and reasoning, the scientific method, and teamwork to solve environmental resource problems and to restore and sustain the global environment.
3. EnvE graduates will be prepared for advanced studies and research and/or employment advancement in a broad spectrum of industries and government agencies.
4. EnvE graduates will communicate effectively in written, spoken, and visual formats with technical, professional, and broader communities.
5. EnvE graduates will practice engineering according to the highest professional standards, demonstrating respect for social, ethical, cultural, environmental, economic, and regulatory concerns.
6. EnvE graduates will be instilled with a desire to pursue life-long learning opportunities including continued education, professional licensure, challenging professional experiences and active participation in professional organizations.

Material Science and Engineering

1. Graduates will demonstrate the ability to apply advanced science (such as chemistry and physics) and engineering principles to materials systems.
2. Graduates will demonstrate an integrated understanding of the scientific and engineering principles that underlie the four major elements of the field: structure, properties, processing, and performance related to materials systems appropriate to the field.
3. Graduates will demonstrate the ability to apply and integrate knowledge from each of the above four elements of the field to solve materials selection and design problems.
4. Graduates will demonstrate the ability to utilize experimental, statistical and computational methods in the context of materials systems.
5. Graduates will demonstrate professional and ethical responsibility.

Mechanical Engineering

a. An ability to apply knowledge of informatics, mathematics, science, and engineering;
b. An ability to design and conduct experiments and numerical simulations, analyze, and interpret general scientific and engineering information;
c. An ability to design a system, component, or process to meet desired needs;
d. An ability to solve multidisciplinary problems;
e. An ability to identify, formulate, and solve engineering problems;
f. An understanding of professional and ethical responsibilities;_
g. An ability to communicate effectively;
h. The broad education necessary to understand the impact of engineering solutions in a social context;
i. A sound basis and motivation to engage in life-long learning and continuing education;
j. A knowledge of contemporary issues;
k. An ability to use the techniques, skills, and modern engineering and scientific tools necessary for engineering practice;
l. A working knowledge of the principles of Mechanics and Thermodynamics and how these principles evolve into other disciplines such as Heat and Mass Transfer, Vibration and Control, Computational Engineering, Mechanical Design, etc.
m. An ability to recognize new forms of thinking and new promising directions in engineering, and an understanding of modern tools of analysis, synthesis and design (such as neural networks, genetic algorithms, adaptive and bio-mimetic design, virtual environments, uncertainty in simulations, life-cycle analysis, etc.);
n. An ability to incorporate interdisciplinary concepts from mathematics, physics, biology, chemistry and other disciplines into engineering solutions and vice-versa.
o. A culminating design experience.

School of Natural Sciences:

Applied Mathematical Sciences

Upon graduating, we expect the students completing the Applied Mathematical Sciences major to have become effective *problem-solvers*, meaning that students will be able to:

1. Solve mathematical problems using analytical methods.
2. Solve mathematical problems using computational methods.
3. Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.
4. Give clear and organized written and verbal explanations of mathematical ideas to a variety of audiences.
5. Model real-world problems mathematically and analyze those models using their mastery of the core concepts.

Biological Sciences

Graduates from the Biological Sciences programs will have demonstrated:

1. An understanding of the tenets of modern biology and an understanding of how cellular functions are integrated at the level of the whole organism to sustain life in functioning ecosystems.
2. An ability to develop and critique hypotheses and to design experiments, models, and/or calculations to address these hypotheses.
3. The ability to use appropriate instrumentation and computational tools to collect, analyze and interpret data.
4. The ability to read, evaluate, interpret, and apply numerical and general scientific information.
5. A familiarity with, and application of safety in good laboratory and field practices.

Chemical Sciences

The Programmatic Learning Outcomes specified for the Chemical Sciences major are:

1. Fundamental knowledge and skills. Students are able to describe the major concepts and theoretical principles in chemistry. They can identify the central ideas underlying the principal subfields of chemistry-- analytical, inorganic, organic, and physical chemistry--as well as the broader interdisciplinary subfields of biological, environmental and materials chemistry. Students are able to operate modern chemical instrumentation, perform chemical syntheses and carry out other essential chemical experiments with strict adherence to sound laboratory techniques as well as good safety and hygiene practices. They know how to use modern web-based methods to effectively search the scientific literature.

2. Scientific methodology. Students have developed the ability to integrate the aforementioned fundamental knowledge and skills into scientific inquiries. They can formulate well-defined and quantitative questions, develop testable hypotheses, design and execute experiments, analyze and interpret the results and reach appropriate conclusions. They are also able to critically analyze the work of other scientists and assess its correctness, importance, and relevance.

3. Communication and teamwork skills. Students are able to write organized and concise reports and present technical information using electronic media, posters and oral presentations. They have developed the communication and teamwork skills that allow them to work effectively both as leaders and as team members in a group.

4. Citizenship, ethics, role of chemistry in society. Students have an appreciation for the role of chemistry in the global society as well as the central role chemistry plays in

other scientific disciplines such as biology, medicine, environmental science, and engineering sciences. They conduct themselves ethically and responsibly in science-related professions.

Earth Systems Science

Upon graduating, we expect students from the Earth Systems Science B.S. program to have achieved the following learning outcomes:

1. Foundational knowledge of physics, chemistry, biology, and mathematics related to Earth systems that supports a working knowledge of basic research methodologies, data analysis, and interpretation for a variety of Earth-related data.
2. Knowledge of major concepts, theoretical principles, experimental findings, and areas of study related to Earth systems science, and comprehension of the interactions between natural Earth systems and human economic, political, and social systems.
3. An ability to employ critical thinking, quantitative and numerical analyses, and hypothesis-driven methods of scientific inquiry in the formulation of research questions, experimental design, application and use of laboratory and field instrumentation, and analysis and interpretation of data related to Earth systems.
4. Effective written and oral communication skills, especially the ability to transmit complex technical information.
5. An ability to work effectively individually and in teams in classroom, laboratory, and field settings.

Physics

Graduates from the Physics B.S. program will have demonstrated the following learning outcomes:

* Physical Principles. Students will be able to apply basic physical principles---including classical mechanics, electricity and magnetism, quantum mechanics, and statistical mechanics---to explain, analyze, and predict a variety of natural phenomena.
* Mathematical Expertise. Students will be able to apply advanced mathematical techniques (e.g., calculus, linear algebra, probability, and statistics) in their explanations, analyses, and predictions of physical phenomena.
* Experimental Techniques. Students will be able to take physical measurements in an experimental laboratory setting and analyze these results to draw conclusions about the physical system under investigation, including whether their data supports or refutes a given physical model.
* Communication and Teamwork Skills. Students will be able to clearly explain their mathematical and physical reasoning, both orally and in writing, and will be able to communicate and work effectively in groups on a common project.

* Research Proficiency. Students will be able to formulate personal research questions that expand their knowledge of physics. Students will be able to apply sound scientific research methods to address these questions, either by researching the current literature or developing independent results.

School of Natural Sciences – Minors:

Natural Science Education

Upon completion of the NSED minor program students are expected to:

1. Comprehensively articulate what constitutes a profession of a science or mathematics teacher including being able to address the following questions:
   a. What constitutes responsibilities and duties of a teacher
   b. What skills and knowledge are necessary to become a successful professional?

2. Demonstrate skills of a beginning teacher such as:
   a. Ability to develop a lesson plan and deliver an effective lesson at the secondary school level,
   b. Design different types of assessments to evaluate students learning,
   c. Distinguish between students with different learning abilities and needs and adapt their teaching methodology to address this diversity.

3. Demonstrate familiarity with requirements, special aspects and structure of California educational system such as:
   a. Credentialing process,
   b. Instructional state standards and requirements,
   c. Strategies to address diverse demographics of California schools such as instruction to English Learners.

School of Social Sciences, Arts and Humanities - Majors:

Anthropology

Upon graduation, students majoring in Anthropology will:

- Possess and apply fundamental anthropological knowledge, including terminology, concepts, intellectual traditions, and theoretical approaches;
- Identify and analyze common topics of research shared by the sub-fields of anthropology;
- Understand ethics and responsibility in the practice of anthropology and in our roles as citizens;
- Recognize and appreciate what it means to be human and how ethnographic, archaeological, and biological knowledge contribute to that understanding;

- Understand both qualitative and quantitative research methods as they apply to anthropological inquiry;
- Possess skills to communicate anthropological knowledge effectively through writing, oral presentation, and data presentation in various formats for diverse audiences.

Cognitive Science

Upon graduation, students majoring in Cognitive Science will be able to:

- Explain and apply knowledge of landmark findings and theories in cognitive science.
- Design, interpret, and evaluate simple behavioral and neuroscientific experiments.
- Interpret and appreciate formal and computational approaches in cognitive science.
- Argue for or against theoretical positions in cognitive science.
- Use a cognitive science education outside of the undergraduate classroom, particularly in the service of careers.

Economics

Upon graduation, we expect our students to:

* Understand the role of organizations and institutions in a society; understand the impact of organizations and institutions on the economic environment and outcomes; and to understand how incentives influence individual and organizational behavior and performance.
* Recognize how government actions affect economic performance and how economic interests influence government decisions.
* Be able to design and conduct research that will inform managerial and policy decision-making; and be able to collect, analyze, and interpret data using familiar software packages.
* Be able to define problems and identify multifaceted explanations for complex economic phenomena; use information and data from multiple sources to answer the questions at hand.
* Think critically about the information that they encounter, whether it is in their work or reported in the media.
* Have an ability to communicate clearly and cogently in written and oral form using modern technology.
* Engage in life-long learning.

History

Upon successful completion of the History major, students will be able to:

- Recognize the processes by which societies, cultures, and institutions change over time.
- Describe particular historical developments and explain their wider context.
- Critically read, analyze, and synthesize primary and secondary sources.
- Use methods of narrative and analysis appropriately for communicating historical phenomena.
- Identify the various contexts that shape the construction and use of historical sources and knowledge.

Literature and Cultures

Students majoring in Literature and Cultures will be able participate in this larger conversation. More specifically, the successful student will be able to:

- Interpret texts with due sensitivity to both textual and contextual cues;
- Appreciate and evaluate the aesthetic qualities of texts and the cultures from which they are drawn;
- Take positions on the ethical questions raised by texts, and defend those positions;
- Apply to other contexts various interpretive strategies developed in literary study;
- Articulate, cogently and with sensitivity to context, in both speech and writing, her/his interpretations and evaluations.

Management

The students who graduate with a major in management will be able to:

- Analyze information, solve problems, and make decision from a holistic, multidisciplinary perspective.
- Apply theories and concepts in management and related fields (accounting, economics, statistics, finance, marketing, human resource management, strategic planning and business law) to various management situations.
- Use effective written and oral communication consistent with the management and professional environment.
- Apply appropriate information technology to analyze problems, develop business research, report key data, and recommend management strategies and actions.
- Evaluate ethical, social, cultural, and political issues as they relate to the organization, operations, human resources, and business ventures.

Political Science

We expect graduates from the Political Science B.A. program to be able to:

- Understand the processes, theories, and empirical regularities of political institutions and political behavior in the student's chosen emphasis area: American politics, comparative politics, or international relations.
- Employ critical thinking and demonstrate social scientific literacy, including basic quantitative literacy.
- Utilize contemporary social science research methods to conduct rigorous research on political phenomena.
- Write effectively, particularly to convey complex concepts and information in a clear and concise manner.
- Apply abstract theory and research methods to understand contemporary political events and public policies.

Psychology

Students who complete the Psychology major will:

- Show knowledge of the key substantive content of the field of psychology, including memory and thinking, sensory psychology and physiology, developmental psychology, clinical and abnormal psychology, and social psychology.
- Demonstrate that they understand the basic principles of and correctly interpret applications of the designs and methods that psychologists use to gather data.
- Show that they can understand and correctly interpret the statistical analyses psychologists use to analyze data.
- Show that they understand and can apply the writing style used in psychological literature (APA style).

School of Social Sciences, Arts and Humanities – Prospective Majors:

Sociology (in May 2009 approved by the UGC as a new program and pending WASC substantive change approval)

Upon completion of a BA in Sociology, students will:

- Think critically about the causes and consequences of social inequality.
- Design and evaluate empirical sociological research.
- Explain and apply the major theoretical perspectives in sociology.
- Communicate orally and in writing about sociological concepts.
- Use their sociological education outside of the undergraduate classroom, particularly in their careers or further education.

School of Social Sciences, Arts and Humanities - Minors:

Arts

Global Arts Studies Program (GASP)

The content of Global Arts Studies Program (GASP) courses is designed to guide students to:

- Describe art works in technical or theoretical terms.
- Enlarge technical/theoretical vocabulary.
- Analyze art works.
- Engage art works critically.

Media Arts Program (MAP)

The content of MAP courses is designed to guide students to:

- Understand and acquire (through hands-on projects) the principal attributes and mechanics of art technique(s) in medium of choice.
- Enhance visual, aural, and physical perception and cognition through the acquisition of art technique.
- Understand, think and communicate critically the aesthetic, historical, cultural, social and contemporary aspects of the medium(media) they are studying.
- Understand the multicultural environment that typifies contemporary art production.
- Understand the relationship between the physical aspects of works of art and aesthetic principles.
- Understand principles that guide artistic creativity and be prepared to apply them imaginatively, as well as practically.
- Express ideas through an art medium.
- Be able to apply their knowledge of art technique and practice outside of the classroom.

Philosophy

Upon graduation, we expect students minoring in philosophy to have gained experience in and be capable of doing each of the following:

- Criticize philosophical arguments, including arguments presented in classic texts and in contemporary philosophical literature.
- Present well-defined claims of one's own, to give clear philosophical arguments in defense of these claims, and to respond to critical objections others might raise against these claims.
- Distinguish between logically valid and invalid deductive arguments, and be able to identify additional premises or logical relationships that could transform an invalid argument into a valid argument.

- Use philosophy in an interdisciplinary way, for example, by philosophically analyzing non-philosophical texts (e.g. texts from literature, history, psychology, or physics), or by using formal methodological tools, such as mathematical and computer models, in the analysis of philosophical problems.

Additionally, we expect students minoring in philosophy to have gained experience in and be capable of doing at least two of the following:

- Provide and assess evidence for causal claims and identify various fallacies in inductive reasoning (e.g. sample bias)
- Distinguish between descriptive and normative philosophical claims, and to use certain descriptive claims either to support or to criticize certain normative claims.
- Appreciate how the discipline of philosophy has developed over time in response to internal challenges and to advances in science and changes in social life. (E.g., the renaissance in philosophy of mind was stimulated in part by the development of contemporary artificial intelligence).

Spanish

Upon finishing the Spanish minor, we expect students to have developed supporting skills in critical thinking, written expression, reading, listening and oral proficiency in Spanish, meaning that students will:

- Possess Spanish listening and speaking skills equivalent at least to the advanced level of the ACTFL Proficiency Guidelines: Understand the main ideas of most speech in a standard dialect and use oral Spanish to speak about a variety of everyday activities, school, and work situations, but also to support opinions, explain in detail and hypothesize.
- Possess Spanish reading skills equivalent at least to the advanced level of the ACTFL Proficiency Guidelines: Understand parts of texts that are conceptually abstract and linguistically complex; demonstrate awareness of the aesthetic properties of language and of its literary styles, which permits comprehension of a wider variety of texts, including literary texts.
- Possess Spanish writing skills equivalent at least to the advanced level of the ACTFL Proficiency Guidelines: the student will be able to write about a variety of topics with significant precision and detail, and to produce organized compositions and short research papers.
- Be able to identify the linguistic and pragmatic components of the Spanish language.
- Demonstrate in their oral presentations, compositions, research papers and other class assignments a reasonable knowledge of the ways of thinking, behavioral practices, and the cultural products of the Spanish-speaking world.

Writing

After completing the minor curriculum, students will be well prepared to do the following activities:

- Collaborate successfully as members of an academic community;
- Analyze and apply the requisite styles, structures, and standards of relevant professions, genres, and academic disciplines;
- Apply ethical standards to the practice of academic research and public discourse;
- Demonstrate thorough engagement with the iterative processes of reading, writing, and speaking;
- Craft language that reveals aesthetic awareness.

GRADUATE PROGRAMS

Environmental Systems

The overarching goal of the Environmental Systems (ES) program is that its graduates be knowledgeable and professionally competent in one or more areas of environmental systems. The following program learning outcomes (PLOs) are being used to attain this goal:

PLO-1: Core Knowledge - Graduates will be knowledgeable, skillful, and self-directed in the observation and analysis of environments systems in terms of their capacity to:

a. (M.S. graduates) Design experiments with appropriate controls and conduct original research, with an appropriate level of supervision, in the context of an M.S. project or thesis
b. (Ph.D. graduates) Independently identify important research questions, formulate experimental plans, data analysis, and formulation of conclusions in the context of a doctoral dissertation

PLO-2: Communication Skills - Graduates will be conversant in at least two area(s) of environmental systems, and be adept at oral, written, and visual communication of research results to peers and non-technical decision makers

PLO-3: Ethics, Community, and Lifelong Learning - Graduates will understand the importance of research and professional ethics, engagement in the needs of their community, and life-long learning

PLO-4: Career Placement and Advancement - Graduates will find suitable career placement and achieve advancement in government agencies, non-government organizations, private industry, and academic teaching and research institutions