

Academics

# Science and Engineering Education



MINERVA<sup>®</sup> SCHOOLS AT KGI

**M**inerva has designed a flexible, student-centered curriculum that enables students to gain the broad lifelong learning skills that come with a liberal arts education, while also obtaining the practical knowledge and hands-on experiences needed for science and engineering. Within the Colleges of Natural Sciences and Computational Sciences, we provide those interested in various science and engineering fields with the knowledge, skills, and experiences necessary to begin successful careers. Minerva educates and prepares students for the best post-graduate opportunities in science and engineering, including, but not limited to, medical school, graduate study or employment in science, as well as technology-oriented industries and government laboratories. Our students majoring in the natural or computational sciences may also choose careers in policy and law, in which their strong science and engineering backgrounds will make them highly competitive, as the world's societies become increasingly more influenced and impacted by science and technology.

Minerva faculty work closely with each student to design an individual study plan based on the student's interests. The flexible curriculum provides students with the fundamentals of science and engineering, enabling them to emphasize specific domains like physics, chemistry, or biology, or to combine disciplines, which is very important for success in the twenty-first century. The six required courses for each major and concentration provide the fundamentals and breadth, while the multiple, individually-designed tutorials and the senior Capstone project provide in-depth exploration of topics the student selects. A key aspect of science and engineering training is providing relevant, practical experiences in authentic research laboratories. Through summer and term-time opportunities in research laboratories around the world, students are able to carry out faculty-mentored research projects, in which they actually do science and engineering, rather than merely learning about it through coursework. Minerva administrators and faculty actively help students obtain such internships.

## A Student-Centered Approach and Many Career Possibilities

In science and engineering we offer six broad concentrations, in both the College of Natural Sciences and the College of Computational Sciences (see sidebar). Students can combine concentrations within a college and across colleges. Following the three foundational courses for the major, individual concentrations have three courses that provide a springboard for further, personalized study.

Central to this approach are senior-year Tutorial courses and the final Capstone project. Each Tutorial consists of three students and a professor, studying a topic chosen by the students; the Capstone project spans two years, and allows students to produce something novel in a field of their choosing. Depending on their interests and career goals, students may also take third- and fourth-year courses from the other colleges.

### Potential Academic Paths in Natural Sciences

The table below illustrates the concentrations a student would pursue, based on area of interest. These examples for the Natural Sciences major should be viewed as only a few of a vast number of study plans students can follow.

Area of Interest	Minerva Concentration(s)
Physical or Chemical Engineering	<b>Double-concentration</b> Molecules and Atoms + Designing Solutions
Bioengineering	<b>Double-concentration</b> Cells and Organisms + Designing Solutions
Graduate Studies in: · Physics · Chemistry · Life Sciences · Earth Sciences	<b>Double-concentration</b> Theoretical Foundations of Natural Science + Second concentration in one of the following: · Molecules and Atoms · Cells and Organisms · Earth's Systems
Health Sciences: · Medicine · Biotechnology	<b>Double-concentration</b> Cells and Organisms + Second concentration in: · Theoretical Foundations of Natural Science · Research Analyses in Natural Science

## Majors & Concentrations

All majors at Minerva are organized into matrices to enable inter- and multidisciplinary studies. Each row and each column of a matrix represents a different concentration, with required courses listed in each cell. This structure allows double-concentration, with only two additional courses.



### Concentrations in Computational Sciences

	<b>Computational Theory and Analysis</b>	<b>Contemporary Knowledge Discovery</b>	<b>Applied Problem Solving</b>
<b>Computer Science and Artificial Intelligence</b>	CS142 / Computability and Complexity	CS152 / Harnessing Artificial Intelligence Algorithms	CS162 / Software Development: Building Powerful Applications
<b>Mathematics and Operations Research</b>	CS144 / Principles of Advanced Mathematics	CS154 / Contemporary Applied Mathematics	CS164 / Optimization Methods
<b>Data Science and Statistics</b>	CS146 / Modern Computational Statistics	CS156 / Machine Learning for Science and Profit	CS166 / Modeling, Simulation, and Decision Making



### Concentrations in Natural Sciences

	<b>Theoretical Foundations of Natural Science</b>	<b>Research Analyses in Natural Science</b>	<b>Designing Solutions</b>
<b>Molecules and Atoms</b>	NS142 / Quantum Nature of Matter: Theory and Applications	NS152 / Analyzing Matter and Molecules	NS162 / Statistical Mechanics: Theory and Applications
<b>Cells and Organisms</b>	NS144 / Genetic Blueprint to Organism	NS154 / Life's Chemistry	NS164 / Solutions From and For Life
<b>Earth's Systems</b>	NS146 / Geobiochemiphysics: Integrating Earth's Systems	NS156 / Monitoring and Modeling Earth's Systems	NS166 / Keeping Earth Habitable

### **Sciences Integrated Into the Curriculum and Classes**

All classes at Minerva are taught as seminars on Forum, our proprietary software platform. Students are not limited to reading about how to do science because the platform provides opportunities for students to explore scientific and engineering methods, through simulations and access to remote facilities.

Because Minerva is not a “bricks and mortar” institution, it does not have teaching laboratories, where in traditional universities science and engineering students practice pre-designed “experiments” (i.e., classroom exercises) and techniques in their physics, chemistry, biology, and engineering classes.

These laboratory courses are typically taught in environments very different from those where actual research is carried out and do not provide students with the skill sets needed for either graduate study or employment in industry. It is now widely recognized that employers and graduate schools are looking for students who have had experience doing actual research with individual faculty, working on real projects (see Experiential Learning).

Students will also take multiple tutorials, in which a total of three students will work with a faculty member to design deeper investigations into areas of interest. These tutorials can be designed to expand on and complement research laboratory experiences in specific areas of science and engineering that meet the student’s learning and career goals. Students will also design and carry out their Capstone Project with faculty guidance.

### **Practical Experience Through Working Partnerships**

Graduate and professional school admissions committees and employers downplay laboratory coursework because it does not actually teach practical knowledge or useful skills. Rather, it is widely recognized that students learn through hands-on experiences in research laboratories. In these experiences students work closely with faculty members and graduate students to generate hypotheses, design and perform experiments. Minerva's approach is to help students learn how to conduct science and/or engineering by experiencing it. At Minerva, students will reside in seven major world cities during their four years, which provides many opportunities to visit and work in research facilities of universities, research institutes, and national and industrial laboratories around the world.

Minerva students also have a four-month long summer break, during which students can complete extensive research-based internships. Numerous opportunities exist, including in the laboratories of Keck Graduate Institute and multiple Research Experiences for Undergraduates (REU) summer programs at multiple universities.

Minerva faculty work closely with individual students to identify summer or academic year opportunities that allow them to explore their research interests. These opportunities might include working directly with Minerva faculty who are actively conducting research, pursuing internships in other laboratories or participating in formal competitive Research Experiences for Undergraduates, such as those supported by the US National Science Foundation or similar programs in other countries.

