Statistics

Bachelor of Arts (BA)

The undergraduate major at Berkeley provides a systematic and thorough grounding in applied and theoretical statistics as well as probability. The quality and dedication of the teaching staff and faculty are extremely high. A major in Statistics from Berkeley is an excellent preparation for a career in science or industry, or for further academic study in a wide variety of fields. The department has particular strength in Machine Learning, a key ingredient of the emerging field of Data Science. It is also very useful to combine studies of statistics and probability with other subjects. Our department excels at interdisciplinary science, and more than half of the department's undergraduate students are double or triple majors.

Students interested in teaching statistics and mathematics in middle or high school should pursue the teaching option within the major. Students interested in teaching should also consider the Cal Teach Program (http://calteach.berkeley.edu).

Declaring the Major

Students should apply in the semester they will complete their prerequisites. For applicants with prerequisites in progress, applications will be reviewed after the grades for all prerequisites are available, 2–3 weeks after finals. For applicants who have completed all prerequisites in a previous term, applications will be reviewed and processed within a week.

For detailed information regarding the process of declaring the major, please see the Statistics Department website. (http://statistics.berkeley.edu/programs/undergrad/major/#HowtoDeclare)

Minor Program

The minor is for students who want to study a significant amount of statistics and probability at the upper division level. For information regarding the requirements, please see the Minor Requirements tab on this page.

For detailed information regarding the process of declaring the minor, please see the Statistics Department website. (http://statistics.berkeley.edu/programs/undergrad/minor)

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All courses taken to fulfill the major requirements below must be taken for graded credit, other than courses listed which are offered on a Pass/No Pass basis only. Other exceptions to this requirement are noted as applicable.
2. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs, with the exception of minors offered outside of the College of Letters & Science.
3. A minimum grade point average (GPA) of 2.0 must be maintained in both upper and lower division courses used to fulfill the major requirements.

4. The requirements below apply to freshmen entering Berkeley in Fall 2018, and transfer students entering in Fall 2020. Freshmen students admitted to Berkeley prior to Fall 2018 and transfer students admitted prior to Fall 2020 are required to complete the requirements as published in the 2017-18 Berkeley Academic Guide (http://guide.berkeley.edu/archive).

For information regarding residency requirements and unit requirements, please see the College Requirements tab.

Prerequisites

Students must earn a minimum 3.2 UC grade point average in the lower division math prerequisites with no lower than a C in each.¹

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1A</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1B</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 54</td>
<td>Linear Algebra and Differential Equations</td>
<td>4</td>
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</table>

A minimum C grade in one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>STAT C8/</td>
<td>Foundations of Data Science</td>
<td>4</td>
</tr>
<tr>
<td>COMPSCI C8/</td>
<td>or STAT 20</td>
<td></td>
</tr>
<tr>
<td>INFO C8</td>
<td>Introduction to Probability and Statistics</td>
<td>4</td>
</tr>
<tr>
<td>or STAT 28</td>
<td>Statistical Methods for Data Science</td>
<td>4</td>
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A minimum B- grade in one of the following:²

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>STAT 134</td>
<td>Concepts of Probability</td>
<td>4</td>
</tr>
<tr>
<td>or STAT 140</td>
<td>Probability for Data Science</td>
<td>4</td>
</tr>
<tr>
<td>STAT 135</td>
<td>Concepts of Statistics</td>
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</table>

Upper Division Requirements (Nine Courses)

Core Statistics Courses (3)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>STAT 133</td>
<td>Concepts in Computing with Data</td>
<td>3</td>
</tr>
<tr>
<td>STAT 134</td>
<td>Concepts of Probability</td>
<td>4</td>
</tr>
<tr>
<td>or STAT 140</td>
<td>Probability for Data Science</td>
<td>4</td>
</tr>
<tr>
<td>STAT 135</td>
<td>Concepts of Statistics</td>
<td>4</td>
</tr>
</tbody>
</table>

Statistics Electives (3)

Select three statistics electives from the following: at least one of the 0-12 selections must have a lab:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 150</td>
<td>Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>STAT 151A</td>
<td>Linear Modelling: Theory and Applications (LAB COURSE)</td>
<td>4</td>
</tr>
<tr>
<td>STAT 152</td>
<td>Sampling Surveys (LAB COURSE)</td>
<td>4</td>
</tr>
<tr>
<td>STAT 153</td>
<td>Introduction to Time Series (LAB COURSE)</td>
<td>4</td>
</tr>
<tr>
<td>STAT 154</td>
<td>Modern Statistical Prediction and Machine Learning (LAB COURSE)</td>
<td>4</td>
</tr>
<tr>
<td>STAT 155</td>
<td>Game Theory</td>
<td>3</td>
</tr>
<tr>
<td>STAT 157</td>
<td>Seminar on Topics in Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 158</td>
<td>The Design and Analysis of Experiments (LAB COURSE)</td>
<td>4</td>
</tr>
<tr>
<td>STAT 159</td>
<td>Reproducible and Collaborative Statistical Data Science (LAB COURSE)</td>
<td>4</td>
</tr>
</tbody>
</table>

Applied Cluster Courses (3)

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¹http://calteach.berkeley.edu
²http://guide.berkeley.edu/archive
Select three applied cluster courses. See Cluster Course Information and Approved Cluster Courses below the Teaching Option requirements.

**Upper Division Requirements: Teaching Option (Nine Courses)**

**Core Statistics Courses (3)**

- STAT 133 Concepts in Computing with Data 3
- STAT 134 Concepts of Probability 4
  or STAT 140 Probability for Data Science
- STAT 135 Concepts of Statistics 4

**Statistics Electives (2)**

Select two of the following; at least one course must include a lab: 7-8

- STAT 150 Stochastic Processes 3
- STAT 151A Linear Modelling: Theory and Applications (LAB COURSE) 4
- STAT 152 Sampling Surveys (LAB COURSE) 4
- STAT 153 Introduction to Time Series (LAB COURSE) 4
- STAT 154 Modern Statistical Prediction and Machine Learning (LAB COURSE) 4
- STAT 155 Game Theory 3
- STAT 157 Seminar on Topics in Probability and Statistics 3
- STAT 158 The Design and Analysis of Experiments (LAB COURSE) 4
- STAT 159 Reproducible and Collaborative Statistical Data Science (LAB COURSE) 4

**Teaching Track Cluster (4)**

- MATH 110 Linear Algebra 4
- MATH 113 Introduction to Abstract Algebra 4
- MATH 151 Mathematics of the Secondary School Curriculum I 4
- MATH 152 Mathematics of the Secondary School Curriculum II 4
  or MATH 153 Mathematics of the Secondary School Curriculum III 4

**Cluster Course Information**

The applied cluster is a chance to learn about areas in which statistics can be applied and to learn specialized techniques not taught in the Statistics Department. Students need to design their own applied cluster. The courses should have a unifying theme. Picking their own applied cluster is a valuable exercise that gives students a chance to explore and refine their interests and to develop a coherent course of study. A preapproved list has been provided below. However, it is not exhaustive. Clusters may consist of courses from more than one department, but at least two must be approved courses from the same department. If students would like to use a course that is not on the list or select three courses from three different departments, the Head Undergraduate Major Faculty Adviser must approve the proposed cluster. Cluster courses should meet the following criteria:

1. Courses must be upper division courses and at least 3 units.
2. Courses in the biological and physical sciences, chemistry, and engineering are often acceptable.
3. Courses in social sciences must be quantitative.
4. Courses with statistics prerequisites are often acceptable.
5. Courses that are similar to courses offered in the Statistics Department are not acceptable.
6. Courses that primarily teach how to use a particular software package are not acceptable.
7. Courses that focus on the use of spreadsheet software (e.g., UG BA 104) are not acceptable.
8. Courses should be taken in the home department. For instance, economics classes should be taken in the economics or business department.
9. Seminars and special topics courses require approval by the undergraduate faculty adviser.

**Approved Cluster Courses**

Of the three applied cluster courses required for the major, at least two must be approved courses from the same department. This is not an exhaustive list.

- ANTHRO C100 Human Paleontology 5
- ANTHRO C103 Introduction to Human Osteology 6
- ANTHRO 115 Introduction to Medical Anthropology 4
- ANTHRO 121C Historical Archaeology: Historical Artifact Identification and Analysis 4
- ANTHRO C124C/ Human Biogeography of the Pacific 3
- INTEGBI C187
- ANTHRO 127A Bioarchaeology: Introduction to Skeletal Biology and Bioarchaeology 4
- ANTHRO 127B Bioarchaeology: Reconstruction of Life in Bioarchaeology 4
- ASTRON 128 Astronomy Data Science Laboratory 4
- ANTHRO C129D/ Holocene Paleoecology: How Humans Changed the Earth 4
- INTEGBI C155 Historical Archaeology: Historical Artifact 4
- ANTHRO 132A Analysis of Archaeological Materials: Analysis of Archaeological Ceramics 4
- ANTHRO 135 Paleoeethnobotany: Archaeological Methods and Laboratory Techniques 4
- ANTHRO 169B Research Theory and Methods in Socio-Cultural Anthropology 5
- ARCH 140 Energy and Environment 4
- ARCH 150 Introduction to Structures 4
- ARCH 154 Design and Computer Analysis of Structure 3
- ASTRON 160 Stellar Physics 4
- ASTRON C161 Relativistic Astrophysics and Cosmology 4
- ASTRON C162 Planetary Astrophysics 4
- BIO ENG 104 Biological Transport Phenomena 4
- BIO ENG C112 Molecular Biomechanics and Mechanobiology of the Cell 4
- BIO ENG C117 Structural Aspects of Biomaterials 4
- BIO ENG C119 Orthopedic Biomechanics 4
- BIO ENG C125 Introduction to Robotics 4
- BIO ENG C125B Robotic Manipulation and Interaction 4
- BIO ENG 131 Introduction to Computational Molecular and Cell Biology 4
- BIO ENG C136L Laboratory in the Mechanics of Organisms 3
- BIO ENG C137 Designing for the Human Body 4
- BIO ENG 144 Introduction to Protein Informatics 4
- BIO ENG C145L Introductory Electronic Transducers Laboratory 3
- BIO ENG C145M Introductory Microcomputer Interfacing Laboratory 3
Introduction to Machine Learning 4
Introduction to Artificial Intelligence 4
Introduction to Database Systems 3
Introduction to Database Systems 4
Foundations of Computer Graphics 4
Neural Networks 4
Algorithms for Computational Biology 4
Computability and Complexity 4
Efficient Algorithms and Intractable Problems 4
Software Engineering 4
Protocols 4
Introduction to the Internet: Architecture and 4
Programming Languages and Compilers 4
Operating Systems and System Programming 4
Computer Security 4
User Interface Design and Development 4
Computer Architecture and Engineering 4
Course Not Available 4
Course Not Available 4
Computational Models of Cognition 4
Cognitive Neuroscience 4
Computational Models of Cognition 4
Quantitative Methods in Linguistics 4
Course Not Available 4
Course Not Available 4
Computer Architecture and Engineering 4
User Interface Design and Development 4
Computer Security 4
Operating Systems and System Programming 4
Programming Languages and Compilers 4
Introduction to the Internet: Architecture and 4
Protocols 4
Software Engineering 4
Efficient Algorithms and Intractable Problems 4
Computability and Complexity 4
Algorithms for Computational Biology 4
Neural Networks 4
Deep Neural Networks 4
Foundations of Computer Graphics 4
Introduction to Database Systems 4
Introduction to Database Systems 4
Introduction to Artificial Intelligence 4
Introduction to Machine Learning 4
NOT CompSci C100
DEMOG 110 Introduction to Population Analysis 3
DEMOG C126 Sex, Death, and Data 4
DEMOG C175 Economic Demography 4
DEMOG 180 Social Networks 4
DEMOG 260 Special Topics in Demography Seminar 1-4
EPS 101 Field Geology and Digital Mapping 4
EPS C129 Biometeorology 3
EPS 130 Strong Motion Seismology 3
EPS C146 Geological Oceanography 4
EPS C162 Planetary Astrophysics 4
EPS C180 Air Pollution 3
EPS C181 Atmospheric Physics and Dynamics 3
ECON 101A Economic Theory--Micro 4
ECON 101B Economic Theory--Macro 4
ECON C102 Natural Resource Economics 4
ECON C103 Introduction to Mathematical Economics 4
ECON 104 Advanced Microeconomic Theory 4
ECON 119 Psychology and Economics 4
ECON 121 Industrial Organization and Public Policy 4
ECON C125 Environmental Economics 4
ECON 131 Public Economics 4
ECON 136 Financial Economics 4
ECON 138 Financial and Behavioral Economics 4
ECON 139 Intermediate Financial Economics 4
ECON 141 Econometric Analysis 4
ECON C142 Applied Econometrics and Public Policy 4
ECON 157 Health Economics 4
ECON C171 Economic Development 4
ECON 174 Global Poverty and Impact Evaluation 4
ECON C175 Economic Demography 3
ECON C181 International Trade 4
ECON 182 International Monetary Economics 4
EL ENG 100 Course Not Available 4
EL ENG 105 Microelectronic Devices and Circuits 4
EL ENG C106A Introduction to Robotics 4
EL ENG C106B Robotic Manipulation and Interaction 4
EL ENG 113 Power Electronics 4
EL ENG 117 Electromagnetic Fields and Waves 4
EL ENG 118 Introduction to Optical Engineering 3
EL ENG 120 Signals and Systems 4
EL ENG 121 Introduction to Digital Communication Systems 4
EL ENG 122 Introduction to Communication Networks 4
EL ENG 123 Digital Signal Processing 4
EL ENG 127 Course Not Available 4
EL ENG C128 Feedback Control Systems 4
EL ENG 129 Neural and Nonlinear Information Processing 3
EL ENG 130 Integrated-Circuit Devices 4
EL ENG 134 Fundamentals of Photovoltaic Devices 4
EL ENG 137A Introduction to Electric Power Systems 4
EL ENG 137B Introduction to Electric Power Systems 4
EL ENG 140  Linear Integrated Circuits  4
EL ENG 142  Integrated Circuits for Communications  4
EL ENG 143  Microfabrication Technology  4
EL ENG 144  Fundamental Algorithms for Systems Modeling, Analysis, and Optimization  4
EL ENG C145B  Medical Imaging Signals and Systems  4
EL ENG C145L  Introductory Electronic Transducers Laboratory  3
EL ENG C145M  Introductory Microcomputer Interfacing Laboratory  3
EL ENG C145O  Laboratory in the Mechanics of Organisms  3
EL ENG 147  Introduction to Microelectromechanical Systems (MEMS)  3
EL ENG C149  Course Not Available  4
ENE,RES C100  Energy and Society  4
ENE,RES 102  Quantitative Aspects of Global Environmental Problems  4
ENE,RES 131  Data, Environment and Society  4
ENE,RES 175  Water and Development  4
ENE,RES C176  Climate Change Economics  4
ENGIN 115  Course Not Available  4
ENGIN 117  Methods of Engineering Analysis  3
ENGIN 120  Principles of Engineering Economics  3
ENVECON C101  Environmental Economics  4
ENVECON C102  Natural Resource Economics  4
ENVECON C115  Modeling and Management of Biological Resources  4
ENVECON 131  Globalization and the Natural Environment  3
ENVECON 140C  Economics of Race, Agriculture, and the Environment  3
ENVECON 141  Agricultural and Environmental Policy  4
ENVECON 142  Industrial Organization with Applications to Agriculture and Natural Resources  4
ENVECON 143  Economics of Innovation and Intellectual Property  4
ENVECON 145  Health and Environmental Economic Policy  4
ENVECON 147  Regulation of Energy and the Environment  4
ENVECON C151  Economic Development  4
ENVECON 152  Advanced Topics in Development and International Trade  3
ENVECON 153  Population, Environment, and Development  3
ENVECON 154  Economics of Poverty and Technology  3
ENVECON 161  Advanced Topics in Environmental and Resource Economics  4
ENVECON 162  Economics of Water Resources  3
ENVECON C175  The Economics of Climate Change  4
ENVECON C176  Climate Change Economics  4
ENVECON C181  International Trade  4
ENVECON C183  Forest Ecosystem Management  4
ENV SCI 100  Course Not Available  

ESPM 102A  Course Not Available  4
ESPM 102C  Resource Management  4
ESPM 102D  Climate and Energy Policy  4
ESPM C103  Principles of Conservation Biology  4
ESPM C104  Modeling and Management of Biological Resources  4
ESPM C107  Biology and Geomorphology of Tropical Islands  13
ESPM 108A  Trees: Taxonomy, Growth, and Structures  3
ESPM 108B  Environmental Change Genetics  3
ESPM 111  Ecosystem Ecology  4
ESPM 112  Microbial Ecology  3
ESPM 114  Wildlife Ecology  3
ESPM 115C  Fish Ecology  3
ESPM 116B  Rangeland Ecology  4
ESPM 116C  Tropical Forest Ecology  3
ESPM 117  Urban Garden Ecosystems  4
ESPM 118  Agricultural Ecology  4
ESPM 120  Soil Characteristics  3
ESPM 121  Development and Classification of Soils  3
ESPM C126  Animal Behavior  4
ESPM C128  Chemistry of Soils  3
ESPM C129  Biometeorology  3
ESPM 131  Soil Microbial Ecology  3
ESPM 132  Spider Biology  4
ESPM C138  Introduction to Comparative Virology  4
ESPM 140  General Entomology  4
ESPM 142  Insect Behavior  3
ESPM 144  Insect Physiology  3
ESPM C148  Pesticide Chemistry and Toxicology  3
ESPM C149  Molecular Ecology  4
ESPM 152  Global Change Biology  3
ESPM 159  Human Diet  4
ESPM 165  International Rural Development Policy  4
ESPM 166  Natural Resource Policy and Indigenous Peoples  4
ESPM 172  Photogrammetry and Remote Sensing  3
ESPM 173  Introduction to Ecological Data Analysis  3
ESPM C177  GIS and Environmental Spatial Data Analysis  4
ESPM C180  Air Pollution  3
ESPM 181A  Fire Ecology  3
ESPM 182  Forest Operations Management  3
ESPM 183  Forest Ecosystem Management and Planning  4
ESPM C183  Forest Ecosystem Management  4
ESPM 185  Applied Forest Ecology  4
ESPM 186  Management and Conservation of Rangeland Ecosystems  3
ESPM 187  Restoration Ecology  4
GEOG C136  Terrestrial Hydrology  4
GEOG C139  Atmospheric Physics and Dynamics  3
GEOG 140A  Physical Landscapes: Process and Form  4
GEOG 142  Climate Dynamics  4
GEOG 143  Global Change Biogeochemistry  3
GEOG C145  Geological Oceanography  4
GEOG 148  Course Not Available  4
GEOG 187  Geographic Information Analysis  4
GEOG C188  Geographic Information Systems  4
IND ENG 115  Industrial and Commercial Data Systems  3
IND ENG 130  Methods of Manufacturing Improvement  3
IND ENG 131  Course Not Available  3
IND ENG 135  Applied Data Science with Venture Applications  3
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<td>IND ENG 142</td>
<td>Introduction to Machine Learning and Data Analytics</td>
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<tr>
<td>IND ENG 150</td>
<td>Production Systems Analysis</td>
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<tr>
<td>IND ENG 151</td>
<td>Service Operations Design and Analysis</td>
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<td>IND ENG 153</td>
<td>Logistics Network Design and Supply Chain Management</td>
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<td>IND ENG 160</td>
<td>Nonlinear and Discrete Optimization</td>
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<td>IND ENG 162</td>
<td>Linear Programming and Network Flows</td>
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<td>IND ENG 166</td>
<td>Decision Analytics</td>
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<tr>
<td>IND ENG 170</td>
<td>Industrial Design and Human Factors</td>
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<tr>
<td>IND ENG 171</td>
<td>Technology Firm Leadership (through fall 2018)</td>
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<td>IND ENG 221</td>
<td>Introduction to Financial Engineering</td>
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<tr>
<td>IND ENG 222</td>
<td>Financial Engineering Systems I</td>
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<tr>
<td>NOT Ind Eng 165, Ind Eng 172 or Ind Eng 173</td>
<td>Data Mining and Analytics</td>
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<tr>
<td>INFO 154</td>
<td>Natural Language Processing</td>
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<tr>
<td>INFO 159</td>
<td>Behind the Data: Humans and Values</td>
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<td>INFO 213</td>
<td>User Interface Design and Development</td>
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<td>INFO 232</td>
<td>Applied Behavioral Economics for Information Systems</td>
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<td>INFO 247</td>
<td>Information Visualization and Presentation</td>
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<tr>
<td>INFO 253</td>
<td>Front-End Web Architecture</td>
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<td>INFO 256</td>
<td>Applied Natural Language Processing</td>
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<td>INFO 257</td>
<td>Database Management</td>
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<td>INFO 271B</td>
<td>Quantitative Research Methods for Information Systems and Management</td>
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<td>INFO 272</td>
<td>Qualitative Research Methods for Information Systems and Management</td>
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<tr>
<td>INTEGBI 102LF</td>
<td>Introduction to California Plant Life with Laboratory</td>
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<tr>
<td>INTEGBI 103LF</td>
<td>Invertebrate Zooiology with Laboratory</td>
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<tr>
<td>INTEGBI 104LF</td>
<td>Natural History of the Vertebrates with Laboratory</td>
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<td>INTEGBI 106A</td>
<td>Physical and Chemical Environment of the Ocean</td>
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<td>INTEGBI C107L</td>
<td>Principles of Plant Morphology with Laboratory</td>
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<td>Evolution and Ecology of Development</td>
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<td>INTEGBI C110L</td>
<td>Biology of Fungi with Laboratory</td>
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<tr>
<td>INTEGBI 113L</td>
<td>Paleobiological Perspectives on Ecology and Evolution</td>
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<tr>
<td>INTEGBI 115</td>
<td>Introduction to Systems in Biology and Medicine</td>
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<tr>
<td>INTEGBI 117</td>
<td>Medical Ethnobotany &amp; Medical Ethnobotany Laboratory</td>
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<tr>
<td>INTEGBI 118</td>
<td>Host-Microbe Interactions</td>
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<tr>
<td>INTEGBI 119</td>
<td>Evaluating Scientific Evidence in Medicine</td>
<td>3</td>
</tr>
<tr>
<td>INTEGBI 123AL</td>
<td>Exercise and Environmental Physiology with Laboratory</td>
<td>5</td>
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<tr>
<td>INTEGBI C125L</td>
<td>Introduction to the Biomechanical Analysis of Human Movement</td>
<td>4</td>
</tr>
<tr>
<td>INTEGBI 128</td>
<td>Sports Medicine</td>
<td>3</td>
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<tr>
<td>INTEGBI C129L</td>
<td>Human Physiological Assessment</td>
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<tr>
<td>INTEGBI 131</td>
<td>General Human Anatomy</td>
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<td>INTEGBI 132</td>
<td>Survey of Human Physiology</td>
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<tr>
<td>INTEGBI 135</td>
<td>The Mechanics of Organisms</td>
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<tr>
<td>INTEGBI C135L</td>
<td>Laboratory in the Mechanics of Organisms</td>
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<tr>
<td>INTEGBI 137</td>
<td>Human Endocrinology</td>
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<tr>
<td>INTEGBI 138</td>
<td>Comparative Endocrinology</td>
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<td>INTEGBI 139</td>
<td>The Neurobiology of Stress</td>
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<td>INTEGBI 140</td>
<td>Biology of Human Reproduction</td>
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<tr>
<td>INTEGBI C142L</td>
<td>Introduction to Human Osteology</td>
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<tr>
<td>INTEGBI C143A</td>
<td>Biological Clocks: Physiology and Behavior</td>
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<tr>
<td>INTEGBI C143B</td>
<td>Hormones and Behavior</td>
<td>3</td>
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<tr>
<td>INTEGBI C144</td>
<td>Animal Behavior</td>
<td>4</td>
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<tr>
<td>INTEGBI 146LF</td>
<td>Behavioral Ecology with Laboratory</td>
<td>5</td>
</tr>
<tr>
<td>INTEGBI 148</td>
<td>Comparative Animal Physiology</td>
<td>3</td>
</tr>
<tr>
<td>INTEGBI C149</td>
<td>Molecular Ecology</td>
<td>4</td>
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<td>INTEGBI C150</td>
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<td>Holocene Paleoecology: How Humans Changed the Earth</td>
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<td>Ecosystems of California</td>
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<td>Population and Evolutionary Genetics</td>
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<td>INTEGBI 175LF</td>
<td>Herpetology with Laboratory</td>
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<td>Paleobotany - The 500-Million Year History of a Greening Planet</td>
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<td>GIS and Environmental Spatial Data Analysis</td>
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<td>LD ARCH C188</td>
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<td>Data, Prediction &amp; Law</td>
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<td>MATH C103</td>
<td>Introduction to Mathematical Economics</td>
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<td>MATH 104</td>
<td>Introduction to Analysis</td>
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<td>Cellular and Molecular Neurobiology</td>
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<td>Circuit, Systems and Behavioral Neuroscience</td>
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<td>MCELLBI 163L</td>
<td>Mammalian Neuroanatomy Lab</td>
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<td>Neurobiology of Disease</td>
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<td>Biophysical Neurobiology</td>
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<td>Music Perception and Cognition</td>
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<td>MUSIC 108M</td>
<td>Music Perception and Cognition</td>
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<td>MUSIC 109</td>
<td>Music Cognition: The Mind Behind the Musical Ear</td>
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<tr>
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<td>Analytical Methods for Non-proliferation</td>
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<td>NUC ENG 175</td>
<td>Methods of Risk Analysis</td>
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<td>Nutrient Function and Metabolism</td>
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<td>PHYS ED C129</td>
<td>Human Physiological Assessment</td>
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<td>PHYS ED C165</td>
<td>Introduction to the Biomechanical Analysis of Human Movement</td>
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<td>PHYSICS 105</td>
<td>Analytic Mechanics</td>
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<td>PHYSICS 110A</td>
<td>Electromagnetism and Optics</td>
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<td>PHYSICS 111A</td>
<td>Instrumentation Laboratory</td>
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<td>PHYSICS 111B</td>
<td>Advanced Experimentation Laboratory (only when taken for 3 units)</td>
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<td>PHYSICS 112</td>
<td>Introduction to Statistical and Thermal Physics</td>
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<td>PHYSICS 129</td>
<td>Particle Physics</td>
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<td>Quantum and Nonlinear Optics</td>
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<td>Special Relativity and General Relativity</td>
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<td>PHYSICS 142</td>
<td>Introduction to Plasma Physics</td>
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<td>PHYSICS 151</td>
<td>Elective Physics: Special Topics</td>
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<td>Relativistic Astrophysics and Cosmology</td>
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<td>PLANTBI C107L</td>
<td>Principles of Plant Morphology with Laboratory</td>
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<td>Evolution and Ecology of Development</td>
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<td>Biology of Fungi with Laboratory</td>
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<td>PLANTBI C112</td>
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<td>California Mushrooms</td>
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<td>Introduction to Comparative Virology</td>
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<td>PLANTBI C116</td>
<td>Microbial Diversity</td>
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<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
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<td>PLANTBI C134</td>
<td>Chromosome Biology/Cytogenetics</td>
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<td>PLANTBI 135</td>
<td>Physiology and Biochemistry of Plants</td>
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<td>PLANTBI C148</td>
<td>Microbial Genomics and Genetics</td>
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<td>PLANTBI 150</td>
<td>Plant Cell Biology</td>
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<td>Plant Molecular Genetics</td>
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<td>PLANTBI 165</td>
<td>Plant-Microbe Interactions</td>
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<td>PLANTBI 185</td>
<td>Techniques in Light Microscopy</td>
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<td>PLANTBI 190</td>
<td>Special Topics in Plant and Microbial Biology (only taken for 3-4 units)</td>
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<td>Applied Econometrics and Public Policy</td>
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<td>Selected Topics in Quantitative Methods</td>
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<td>Introduction to Biological Psychology</td>
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<td>Biological Clocks: Physiology and Behavior</td>
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<td>Biology of Learning</td>
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<td>Hormones and Behavior</td>
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<td>Human Neuropsychology</td>
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<td>Basic Issues in Cognition</td>
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<td>Animal Cognition</td>
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<td>The Developing Brain</td>
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<td>Perception</td>
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<td>Scientific Approaches to Consciousness</td>
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<td>Clinical Psychology</td>
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<td>Developmental Psychopathology</td>
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<td>PSYCH 133</td>
<td>Psychology of Sleep</td>
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<td>Developmental Psychology</td>
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<td>Development During Infancy</td>
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<td>Language Acquisition</td>
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<td>Psychology of Personality</td>
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<td>PSYCH 164</td>
<td>Social Cognition</td>
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<td>Bacterial Pathogenesis</td>
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<td>PB HLTH 112</td>
<td>Global Health: A Multidisciplinary Examination</td>
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<td>PB HLTH 126</td>
<td>Health Economics and Public Policy</td>
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<td>Introduction to Epidemiology and Human Disease</td>
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<td>Introduction to Environmental Health Sciences</td>
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<td>PB HLTH 162A</td>
<td>Public Health Microbiology</td>
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<td>PB HLTH 250A</td>
<td>Epidemiologic Methods I</td>
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<td>Modeling the Dynamics of Infectious Disease Processes (only taken for 3-4 units)</td>
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<td>PUB POL 101</td>
<td>Introduction to Public Policy Analysis</td>
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</table>
If MATH 110 or MATH H110 has been used to satisfy the math prerequisite requirement, course cannot be used for the applied cluster.

MATH 170 cannot be combined with either IND ENG 160 or IND ENG 162.

Students who have a strong interest in an area of study outside their major often decide to complete a minor program. These programs have set requirements and are noted officially on the transcript in the memoranda section, but they are not noted on diplomas.

**General Guidelines**

1. All minors must be declared no later than one semester before a student’s Expected Graduation Term (EGT). If the semester before EGT is fall or spring, the deadline is the last day of RRR week. If the semester before EGT is summer, the deadline is the final Friday of Summer Sessions. To declare a minor, contact the department advisor for information on requirements, and the declaration process.

2. All courses taken to fulfill the minor requirements below must be taken for graded credit.

3. A minimum of three of the upper division courses taken to fulfill the minor requirements must be completed at UC Berkeley.

4. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.

5. Courses used to fulfill the minor requirements may be applied toward the Seven-Course Breadth requirement, for Letters & Science students.

6. No more than one upper division course may be used to simultaneously fulfill requirements for a student’s major and minor programs.

7. All minor requirements must be completed prior to the last day of finals during the semester in which the student plans to graduate. Students who cannot finish all courses required for the minor by that time should see a College of Letters & Science adviser.

8. All minor requirements must be completed within the unit ceiling. (For further information regarding the unit ceiling, please see the College Requirements tab.)

**Requirements**

**Lower Division Prerequisites**

MATH 1A  Calculus  4
MATH 1B  Calculus  4
MATH 53  Multivariable Calculus  4
MATH 54  Linear Algebra and Differential Equations  4

**Upper Division Requirements**

<table>
<thead>
<tr>
<th>STAT 134</th>
<th>Concepts of Probability 4</th>
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<tbody>
<tr>
<td>or STAT 140</td>
<td>Probability for Data Science 4</td>
</tr>
<tr>
<td>STAT 135</td>
<td>Concepts of Statistics 4</td>
</tr>
<tr>
<td>Select three statistics electives from the following: at least one of the selections must have a lab:</td>
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<tr>
<td>STAT 150</td>
<td>Stochastic Processes 3</td>
</tr>
<tr>
<td>STAT 151A</td>
<td>Linear Modelling: Theory and Applications (LAB COURSE) 4</td>
</tr>
<tr>
<td>STAT 152</td>
<td>Sampling Surveys (LAB COURSE) 4</td>
</tr>
<tr>
<td>STAT 153</td>
<td>Introduction to Time Series (LAB COURSE) 4</td>
</tr>
<tr>
<td>STAT 154</td>
<td>Modern Statistical Prediction and Machine Learning (LAB COURSE) 4</td>
</tr>
</tbody>
</table>

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1. Students who have completed any of the math prerequisites at a non-UC institution should look at the Statistics Major Frequently Asked Questions (http://statistics.berkeley.edu/programs/undergrad/major/faq) on the Statistics Department website.
2. No more than one course repeated between STAT 134 (or STAT 140) and STAT 135.
3. Other non-statistics UC Berkeley courses, such as IND ENG 172, cannot be used to fulfill this requirement.
4. Due to overlap of course content, only one course from STAT 154, COMPSCI 182, COMPSCI 189, and IND ENG 142 can be used to satisfy Statistics major requirements.
5. Due to overlap of course content, only one course from ECON 136, ENGIN 120 and UGBA 103 can be used to satisfy Statistics major requirements.
Statistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>STAT 155</td>
<td>Game Theory</td>
<td>3</td>
</tr>
<tr>
<td>STAT 157</td>
<td>Seminar on Topics in Probability and Statistics</td>
<td>3</td>
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<tr>
<td>STAT 158</td>
<td>The Design and Analysis of Experiments (LAB COURSE)</td>
<td>4</td>
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<tr>
<td>STAT 159</td>
<td>Reproducible and Collaborative Statistical Data Science (LAB COURSE)</td>
<td>4</td>
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</tbody>
</table>

Undergraduate students must fulfill the following requirements in addition to those required by their major program.

For detailed lists of courses that fulfill college requirements, please review the College of Letters & Sciences (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science) page in this Guide. For College advising appointments, please visit the L&S Advising (https://ls.berkeley.edu/advising/about-undergraduate-advising-services) Pages.

University of California Requirements

Entry Level Writing (http://writing.berkeley.edu/node/78)

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing requirement. Fulfillment of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

American History and American Institutions (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/american-history-institutions-requirement)

The American History and Institutions requirements are based on the principle that a US resident graduated from an American university, should have an understanding of the history and governmental institutions of the United States.

Berkeley Campus Requirement

American Cultures (http://americancultures.berkeley.edu/students/courses)

All undergraduate students at Cal need to take and pass this course in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity and culture of the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

College of Letters & Science Essential Skills Requirements

Quantitative Reasoning (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/quantitative-reasoning-requirement)

The Quantitative Reasoning requirement is designed to ensure that students graduate with basic understanding and competency in math, statistics, or computer science. The requirement may be satisfied by exam or by taking an approved course.

Foreign Language (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/foreign-language-requirement)

The Foreign Language requirement may be satisfied by demonstrating proficiency in reading comprehension, writing, and conversation in a foreign language equivalent to the second semester college level, either by passing an exam or by completing approved course work.

Reading and Composition (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/reading-composition-requirement)

In order to provide a solid foundation in reading, writing, and critical thinking the College requires two semesters of lower division work in composition in sequence. Students must complete parts A & B reading and composition courses by the end of their second semester and a second-level course by the end of their fourth semester.

College of Letters & Science 7 Course Breadth Requirements

Breadth Requirements (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/#breadthrequirementstext)

The undergraduate breadth requirements provide Berkeley students with a rich and varied educational experience outside of their major program. As the foundation of a liberal arts education, breadth courses give students a view into the intellectual life of the University while introducing them to a multitude of perspectives and approaches to research and scholarship. Engaging students in new disciplines and with peers from other majors, the breadth experience strengthens interdisciplinary connections and context that prepares Berkeley graduates to understand and solve the complex issues of their day.

Unit Requirements

- 120 total units
- Of the 120 units, 36 must be upper division units
- Of the 36 upper division units, 6 must be taken in courses offered outside your major department

Residence Requirements

For units to be considered in “residence,” you must be registered in courses on the Berkeley campus as a student in the College of Letters & Science. Most students automatically fulfill the residence requirement by attending classes here for four years. In general, there is no need to be concerned about this requirement, unless you go abroad for a semester or year or want to take courses at another institution or through UC Extension during your senior year. In these cases, you should make an appointment to meet an adviser to determine how you can meet the Senior Residence Requirement.

Note: Courses taken through UC Extension do not count toward residence.

Senior Residence Requirement

After you become a senior (with 90 semester units earned toward your BA degree), you must complete at least 24 of the remaining 30 units in residence in at least two semesters. To count as residence, a semester must consist of at least 6 passed units. Inter campus Visitor, EAP, and UC Berkeley-Washington Program (UCDC) units are excluded.

You may use a Berkeley Summer Session to satisfy one semester of the Senior Residence requirement, provided that you successfully complete 6 units of course work in the Summer Session and that you have been enrolled previously in the college.

Modified Senior Residence Requirement

Participants in the UC Education Abroad Program (EAP), Berkeley Summer Abroad, or the UC Berkeley Washington Program (UCDC)
may meet a Modified Senior Residence requirement by completing 24 (excluding EAP) of their final 60 semester units in residence. At least 12 of these 24 units must be completed after you have completed 90 units.

**Upper Division Residence Requirement**
You must complete in residence a minimum of 18 units of upper division courses (excluding UCEAP units), 12 of which must satisfy the requirements for your major.

**Mission**
Statisticians help to design data collection plans, analyze data appropriately, and interpret and draw conclusions from those analyses. The central objective of the undergraduate major in Statistics is to equip students with consequently requisite quantitative skills that they can employ and build on in flexible ways.

**Learning Goals for the Major**
Majors are expected to learn concepts and tools for working with data and have experience in analyzing real data that goes beyond the content of a service course in statistical methods for non-majors. Majors should understand the following:

1. The fundamentals of probability theory
2. Statistical reasoning and inferential methods
3. Statistical computing
4. Statistical modeling and its limitations

**Skills**
Graduates should also have skills in the following:

1. Description, interpretation, and exploratory analysis of data by graphical and other means
2. Effective communication

**Statistics**
Expand all course descriptions [+]
Collapse all course descriptions [-]

**STAT 0PX Preparatory Statistics 1 Unit**
Terms offered: Summer 2016 10 Week Session, Summer 2015 10 Week Session, Summer 2014 10 Week Session
This course assists entering Freshman students with basic statistical concepts and problem solving. Designed for students who do not meet the prerequisites for 2. Offered through the Student Learning Center.

Preparatory Statistics: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Hours & Format**

**Summer:**
6 weeks - 5 hours of lecture and 4.5 hours of workshop per week
8 weeks - 5 hours of lecture and 4.5 hours of workshop per week

**Additional Details**

**Subject/Course Level:** Statistics/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam required.

**Instructor:** Purves

Preparatory Statistics: Read Less [-]

**STAT 2 Introduction to Statistics 4 Units**
Terms offered: Fall 2019, Summer 2019 8 Week Session, Summer 2019 Second 6 Week Session

Introduction to Statistics: Read More [+]

**Rules & Requirements**

**Credit Restrictions:** Students who have taken 2X, 5, 20, 21, 21X, or 25 will receive no credit for 2.

**Hours & Format**

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

**Summer:**
6 weeks - 7.5 hours of lecture and 5 hours of laboratory per week
8 weeks - 5 hours of lecture and 4 hours of laboratory per week

**Additional Details**

**Subject/Course Level:** Statistics/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Introduction to Statistics: Read Less [-]
STAT C8 Foundations of Data Science 4 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019, Fall 2018, Summer 2018 8 Week Session, Spring 2018
Foundations of data science from three perspectives: inferential thinking, computational thinking, and real-world relevance. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? The course teaches critical concepts and skills in computer programming and statistical inference, in conjunction with hands-on analysis of real-world datasets, including economic data, document collections, geographical data, and social networks. It delves into social and legal issues surrounding data analysis, including issues of privacy and data ownership.
Foundations of Data Science: Read More [+]

Rules & Requirements
Prerequisites: This course may be taken on its own, but students are encouraged to take it concurrently with a data science connector course (numbered 88 in a range of departments)

Hours & Format
Fall and/or spring: 15 weeks - 3-3 hours of lecture and 2-2 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture and 4 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: COMPSCI C8/INFO C8
Foundations of Data Science: Read Less [-]

STAT C8R Introduction to Computational Thinking with Data 3 Units
Terms offered: Prior to 2007
An introduction to computational thinking and quantitative reasoning, preparing students for further coursework, especially Foundations of Data Science (CS/Info/Stat C8). Emphasizes the use of computation to gain insight about quantitative problems with real data. Expressions, data types, collections, and tables in Python. Programming practices, abstraction, and iteration. Visualizing univariate and bivariate data with bar charts, histograms, plots, and maps. Introduction to statistical concepts including averages and distributions, predicting one variable from another, association and causality, probability and probabilistic simulation. Relationship between numerical functions and graphs. Sampling and introduction to inference.
Introduction to Computational Thinking with Data: Read More [+]

Objectives & Outcomes
Course Objectives: C8R also includes quantitative reasoning concepts that aren’t covered in Data 8. These include certain topics in: principles of data visualization; simulation of random processes; and understanding numerical functions through their graphs. This will help prepare students for computational and quantitative courses other than Data 8. C8R takes advantage of the complementarity of computing and quantitative reasoning to enliven abstract ideas and build students’ confidence in their ability to solve real problems with quantitative tools. Students learn computer science concepts and immediately apply them to plot functions, visualize data, and simulate random events.

Foundations of Data Science (CS/Info/Stat C8, a.k.a. Data 8) is an increasingly popular class for entering students at Berkeley. Data 8 builds students’ computing skills in the first month of the semester, and students rely on these skills as the course progresses. For some students, particularly those with little prior exposure to computing, developing these skills benefits from further time and practice. C8R is a rapid introduction to Python programming, visualization, and data analysis, which will prepare students for success in Data 8.

Student Learning Outcomes: Students will be able to perform basic computations in Python, including working with tabular data. Students will be able to understand basic probabilistic simulations. Students will be able to understand the syntactic structure of Python code. Students will be able to use good practices in Python programming. Students will be able to use visualizations to understand univariate data and to identify associations or causal relationships in bivariate data.

Rules & Requirements
Credit Restrictions: Students who have taken COMPSCI/INFO/STAT C8 will receive no credit for COMPSCI/STAT C8R.

Hours & Format
Summer: 6 weeks - 4 hours of lecture, 2 hours of discussion, and 4 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Adhikari
Also listed as: COMPSCI C8R
Introduction to Computational Thinking with Data: Read Less [-]
STAT 20 Introduction to Probability and Statistics 4 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
For students with mathematical background who wish to acquire basic concepts. Relative frequencies, discrete probability, random variables, expectation. Testing hypotheses. Estimation. Illustrations from various fields.
Introduction to Probability and Statistics: Read More [+]
Rules & Requirements
Prerequisites: One semester of calculus
Credit Restrictions: Students who have taken 2, 2X, 5, 21, 21X, or 25 will receive no credit for 20.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

STAT W21 Introductory Probability and Statistics for Business 4 Units
Terms offered: Summer 2019 8 Week Session, Spring 2019, Summer 2018 8 Week Session
Reasoning and fallacies, descriptive statistics, probability models and related concepts, combinatorics, sample surveys, estimates, confidence intervals, tests of significance, controlled experiments vs. observational studies, correlation and regression.
Introductory Probability and Statistics for Business: Read More [+]
Rules & Requirements
Prerequisites: One semester of calculus

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week
Summer: 8 weeks - 7.5 hours of web-based lecture per week
Online: This is an online course.

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

Formerly known as: N21

STAT 24 Freshman Seminars 1 Unit
Terms offered: Fall 2016, Fall 2003, Spring 2001
The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley seminars are offered in all campus departments, and topics vary from department to department and semester to semester. Enrollment limited to 15 freshmen.

Freshman Seminars: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format
Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminars: Read Less [-]
STAT 28 Statistical Methods for Data Science
4 Units
Terms offered: Spring 2018, Spring 2017
This is a lower-division course that is a follow-up to STAT8/CS8 (Foundations of Data Science). The course will teach a broad range of statistical methods that are used to solve data problems. Topics will include group comparisons and ANOVA, standard parametric statistical models, multivariate data visualization, multiple linear regression and classification, classification and regression trees and random forests. An important focus of the course will be on statistical computing and reproducible statistical analysis. The students will be introduced to the widely used R statistical language and they will obtain hands-on experience in implementing a range of commonly used statistical methods on numerous real world datasets.

Rules & Requirements

Prerequisites: Statistics/Information/Computer Science C8 is the only course prerequisite. In addition, mathematical fluency and comfort at the level of precalculus (Math 32) is expected

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Introduction to Programming in R
1 Unit
Terms offered: Fall 2019
An introduction to the R statistical software for students with minimal prior experience with programming. This course prepares students for data analysis with R. The focus is on the computational model that underlies the R language with the goal of providing a foundation for coding. Topics include data types and structures, such as vectors, data frames and lists; the REPL evaluation model; function calls, argument matching, and environments; writing simple functions and control flow. Tools for reading, analyzing, and plotting data are covered, such as data input/output, reshaping data, the formula language, and graphics models.

Rules & Requirements

Credit Restrictions: Students will receive no credit for STAT 33A after completing STAT 33B, or STAT 133. A deficient grade in STAT 33A may be removed by taking STAT 33B, or STAT 133.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 1 hour of laboratory per week

Summer: 6 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.
STAT 33B Introduction to Advanced Programming in R 1 Unit
Terms offered: Fall 2019
The course is designed primarily for those who are already familiar with programming in another language, such as python, and want to understand how R works, and for those who already know the basics of R programming and want to gain a more in-depth understanding of the language in order to improve their coding. The focus is on the underlying paradigms in R, such as functional programming, atomic vectors, complex data structures, environments, and object systems. The goal of this course is to better understand programming principles in general and to write better R code that capitalizes on the language's design.

Introduction to Advanced Programming in R: Read More [+]

Rules & Requirements

Prerequisites: Compsci 61A or equivalent programming background

Credit Restrictions: Students will receive no credit for STAT 33B after completing STAT 133. A deficient grade in STAT 33B may be removed by taking STAT 133.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 1 hour of laboratory per week
Summer: 6 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

STAT 39D Freshman/Sophomore Seminar 2 - 4 Units
Terms offered: Fall 2008, Fall 2007
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester.

Freshman/Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: Priority given to freshmen and sophomores

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]

STAT C79 Societal Risks and the Law 3 Units
Terms offered: Spring 2013
Defining, perceiving, quantifying and measuring risk; identifying risks and estimating their importance; determining whether laws and regulations can protect us from these risks; examining how well existing laws work and how they could be improved; evaluating costs and benefits. Applications may vary by term. This course cannot be used to complete engineering unit or technical elective requirements for students in the College of Engineering.

Societal Risks and the Law: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Also listed as: COMPSCI C79/POL SCI C79

STAT 88 Probability and Mathematical Statistics in Data Science 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
In this connector course we will state precisely and prove results discovered while exploring data in Data 8. Topics include: probability, conditioning, and independence; random variables; distributions and joint distributions; expectation, variance, tail bounds; Central Limit Theorem; symmetries in random permutations; prior and posterior distributions; probabilistic models; bias-variance tradeoff; testing hypotheses; correlation and the regression model.

Probability and Mathematical Statistics in Data Science: Read More [+]

Rules & Requirements

Prerequisites: Prerequisite: one semester of calculus at the level of Math 16A, Math 10A, or Math 1A. Corequisite or Prerequisite: Foundations of Data Science (COMPSCI C8 / DATASCI C8 / INFO C8 / STAT C8)

Credit Restrictions: Students will receive no credit for STAT 88 after completing STAT 134, STAT 140, STAT 135, or STAT 102.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Probability and Mathematical Statistics in Data Science: Read Less [-]
STAT 89A Linear Algebra for Data Science 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
An introduction to linear algebra for data science. The course will cover introductory topics in linear algebra, starting with the basics: discrete probability and how probability can be used to understand high-dimensional vector spaces; matrices and graphs as popular mathematical structures with which to model data (e.g., as models for term-document corpora, high-dimensional regression problems, ranking/classification of web data, adjacency properties of social network data, etc.); and geometric approaches to eigendecompositions, least-squares, principal components analysis, etc.
Linear Algebra for Data Science: Read More [+]
Rules & Requirements
Prerequisites: One year of calculus. Prerequisite or corequisite: Foundations of Data Science (COMPSCI C8 / INFO C8 / STAT C8)

STAT 94 Special Topics in Probability and Statistics 1 - 4 Units
Terms offered: Fall 2015
Topics will vary semester to semester.
Special Topics in Probability and Statistics: Read More [+]
Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit when topic changes.

STAT 97 Field Study in Statistics 1 - 3 Units
Terms offered: Fall 2015, Spring 2012
Supervised experience relevant to specific aspects of statistics in off-campus settings. Individual and/or group meetings with faculty.
Field Study in Statistics: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.

STAT 98 Directed Group Study 1 - 3 Units
Terms offered: Fall 2014, Fall 2013, Spring 2013
Must be taken at the same time as either Statistics 2 or 21. This course assists lower division statistics students with structured problem solving, interpretation and making conclusions.
Directed Group Study: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.
STAT C100 Principles & Techniques of Data Science 4 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019, Fall 2018
In this course, students will explore the data science lifecycle, including question formulation, data collection and cleaning, exploratory data analysis and visualization, statistical inference and prediction, and decision-making. This class will focus on quantitative critical thinking and key principles and techniques needed to carry out this cycle. These include languages for transforming, querying and analyzing data; algorithms for machine learning methods including regression, classification and clustering; principles behind creating informative data visualizations; statistical concepts of measurement error and prediction; and techniques for scalable data processing.

Principles & Techniques of Data Science: Read More [+]

Rules & Requirements
Prerequisites: Computer Science/Information/Statistics C8; and either Computer Science 61A, Computer Science 88 or Engineering 7. Corequisite: Mathematics 54 or Electrical Engineering 16A. Computer Science C8 Computer Science 61A Computer Science 88 Engineering 7
Mathematics 54 Electrical Engineering 16A

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week
Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: COMPSCI C100

Principles & Techniques of Data Science: Read Less [-]

STAT 102 Data, Inference, and Decisions 4 Units
Terms offered: Fall 2019, Spring 2001, Spring 2000
This course develops the probabilistic foundations of inference in data science, and builds a comprehensive view of the modeling and decision-making life cycle in data science including its human, social, and ethical implications. Topics include: frequentist and Bayesian decision-making, permutation testing, false discovery rate, probabilistic interpretations of models, Bayesian hierarchical models, basics of experimental design, confidence intervals, causal inference, Thompson sampling, optimal control, Q-learning, differential privacy, clustering algorithms, recommendation systems and an introduction to machine learning tools including decision trees, neural networks and ensemble methods.

Data, Inference, and Decisions: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 54 or Mathematics 110 or Statistics 89A or Physics 89 or both of Electrical Engineering and Computer Science 16A and Electrical Engineering and Computer Science 16B; Statistics/Computer Science C100; and any of Electrical Engineering and Computer Science 126, Statistics 140, Statistics 134, Industrial Engineering and Operations Research 172. Statistics 140 or Electrical Engineering and Computer Science 126 are preferred

Credit Restrictions: Students will receive no credit for STAT 102 after completing STAT 102. A deficient grade in STAT 102 may be removed by taking STAT 102.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

Data, Inference, and Decisions: Read Less [-]
STAT 131A Statistical Methods for Data Science 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
This course teaches a broad range of statistical methods that are used to solve data problems. Topics include group comparisons and ANOVA, standard parametric statistical models, multivariate data visualization, multiple linear regression, logistic regression and classification, regression trees and random forests. An important focus of the course is on statistical computing and reproducible statistical analysis. The course and lab include hands-on experience in analyzing real world data from the social, life, and physical sciences. The R statistical language is used. Statistical Methods for Data Science: Read More [+]

Rules & Requirements

Prerequisites: Statistics/Computer Science/Information C8 or Statistics 20; and Mathematics 1A, Mathematics 16A, or Mathematics 10A/10B. Strongly recommended corequisite: Statistics 33A or Statistics 133

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Statistical Methods for Data Science: Read Less [-]

STAT 133 Concepts in Computing with Data 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
An introduction to computationally intensive applied statistics. Topics will include organization and use of databases, visualization and graphics, statistical learning and data mining, model validation procedures, and the presentation of results.

Concepts in Computing with Data: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Summer: 10 weeks - 4 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Concepts in Computing with Data: Read Less [-]

STAT 134 Concepts of Probability 4 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
An introduction to probability, emphasizing concepts and applications. Conditional expectation, independence, laws of large numbers. Discrete and continuous random variables. Central limit theorem. Selected topics such as the Poisson process, Markov chains, characteristic functions.

Concepts of Probability: Read More [+]

Rules & Requirements

Prerequisites: One year of calculus

Credit Restrictions: Students will not receive credit for 134 after taking 140 or 201A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Summer: 8 weeks - 6 hours of lecture and 4 hours of discussion per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Concepts of Probability: Read Less [-]

STAT 135 Concepts of Statistics 4 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
A comprehensive survey course in statistical theory and methodology. Topics include descriptive statistics, maximum likelihood estimation, non-parametric methods, introduction to optimality, goodness-of-fit tests, analysis of variance, bootstrap and computer-intensive methods and least squares estimation. The laboratory includes computer-based data-analytic applications to science and engineering.

Concepts of Statistics: Read More [+]

Rules & Requirements

Prerequisites: STAT 134 or STAT 140; and MATH 54, EL ENG 16A, STAT 89A, MATH 110 or equivalent linear algebra. Strongly recommended corequisite: STAT 133

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Concepts of Statistics: Read Less [-]
STAT 140 Probability for Data Science 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Probability for Data Science: Read More [+]

Objectives & Outcomes

Course Objectives: The emphasis on simulation and the bootstrap in Data 8 gives students a concrete sense of randomness and sampling variability. Stat 140 will capitalize on this, abstraction and computation complementing each other throughout.

The syllabus has been designed to maintain a mathematical level at least equal to that in Stat 134. So Stat 140 will start faster than Stat 134 (due to the Data 8 prerequisite), avoid approximations that are unnecessary when SciPy is at hand, and replace some of the routine calculus by symbolic math done in SymPy. This will create time for a unit on the convergence and reversibility of Markov Chains as well as added focus on conditioning and Bayes methods.

With about a thousand students a year taking Foundations of Data Science (Stat/CS/Info C8, a.k.a. Data 8), there is considerable demand for follow-on courses that build on the skills acquired in that class. Stat 140 is a probability course for Data 8 graduates who have also had a year of calculus and wish to go deeper into data science.

Student Learning Outcomes: Understand the difference between math and simulation, and appreciate the power of both
Use a variety of approaches to problem solving
Work with probability concepts algebraically, numerically, and graphically

Rules & Requirements

Prerequisites: Statistics/Computer Science/Information C8, or Statistics/Computer Science C100, or both Stat 20 and Computer Science 61A; and one year of calculus at the level of Mathematics 1A-1B or higher. Corequisite: Mathematics 54, Electrical Engineering 16A, Statistics 89A, Mathematics 110 or equivalent linear algebra

Credit Restrictions: Students who have earned credit for Stat 134 will not receive credit for Stat 140.

Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 1 hour of supplement per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Probability for Data Science: Read Less [-]

STAT 150 Stochastic Processes 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Random walks, discrete time Markov chains, Poisson processes. Further topics such as: continuous time Markov chains, queueing theory, point processes, branching processes, renewal theory, stationary processes, Gaussian processes.
Stochastic Processes: Read More [+]

Rules & Requirements

Prerequisites: 101 or 103A or 134

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Stochastic Processes: Read Less [-]

STAT 151A Linear Modelling: Theory and Applications 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
A coordinated treatment of linear and generalized linear models and their application. Linear regression, analysis of variance and covariance, random effects, design and analysis of experiments, quality improvement, log-linear models for discrete multivariate data, model selection, robustness, graphical techniques, productive use of computers, in-depth case studies.
Linear Modelling: Theory and Applications: Read More [+]

Rules & Requirements

Prerequisites: STAT 102 or STAT 135. STAT 133 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Linear Modelling: Theory and Applications: Read Less [-]
STAT 152 Sampling Surveys 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Sampling Surveys: Read More [+]

Rules & Requirements
Prerequisites: 101 or 134. 133 and 135 recommended

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Sampling Surveys: Read Less [-]

STAT 153 Introduction to Time Series 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
An introduction to time series analysis in the time domain and spectral domain. Topics will include: estimation of trends and seasonal effects, autoregressive moving average models, forecasting, indicators, harmonic analysis, spectra.
Introduction to Time Series: Read More [+]

Rules & Requirements
Prerequisites: 101, 134 or consent of instructor. 133 or 135 recommended

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Introduction to Time Series: Read Less [-]

STAT 154 Modern Statistical Prediction and Machine Learning 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Modern Statistical Prediction and Machine Learning: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 53 or equivalent; Mathematics 54, Electrical Engineering 16A, Statistics 89A, Mathematics 110 or equivalent linear algebra; Statistics 135 or equivalent; experience with some programming language. Recommended prerequisite: Mathematics 55 or equivalent exposure to counting arguments

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week
Summer: 10 weeks - 4.5 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Modern Statistical Prediction and Machine Learning: Read Less [-]

STAT 155 Game Theory 3 Units
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
General theory of zero-sum, two-person games, including games in extensive form and continuous games, and illustrated by detailed study of examples.
Game Theory: Read More [+]

Rules & Requirements
Prerequisites: 101 or 134

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Summer: 8 weeks - 6 hours of lecture per week

Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Game Theory: Read Less [-]
STAT 157 Seminar on Topics in Probability and Statistics 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2017
Substantial student participation required. The topics to be covered each semester that the course may be offered will be announced by the middle of the preceding semester; see departmental bulletins. Recent topics include: Bayesian statistics, statistics and finance, random matrix theory, high-dimensional statistics.
Seminar on Topics in Probability and Statistics: Read More [+]
Rules & Requirements
Prerequisites: Mathematics 53-54, Statistics 134, 135. Knowledge of scientific computing environment (R or Matlab) often required. Prerequisites might vary with instructor and topics
Repeat rules: Course may be repeated for credit with instructor consent.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of seminar per week
Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Seminar on Topics in Probability and Statistics: Read Less [-]

STAT 158 The Design and Analysis of Experiments 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
An introduction to the design and analysis of experiments. This course covers planning, conducting, and analyzing statistically designed experiments with an emphasis on hands-on experience. Standard designs studied include factorial designs, block designs, latin square designs, and repeated measures designs. Other topics covered include the principles of design, randomization, ANOVA, response surface methodology, and computer experiments.
The Design and Analysis of Experiments: Read More [+]
Rules & Requirements
Prerequisites: Statistics 134 and 135 or consent of instructor. Statistics 135 may be taken concurrently. Statistics 133 is recommended
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week
Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
The Design and Analysis of Experiments: Read Less [-]

STAT 159 Reproducible and Collaborative Statistical Data Science 4 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
A project-based introduction to statistical data analysis. Through case studies, computer laboratories, and a term project, students will learn practical techniques and tools for producing statistically sound and appropriate, reproducible, and verifiable computational answers to scientific questions. Course emphasizes version control, testing, process automation, code review, and collaborative programming. Software tools may include Bash, Git, Python, and LaTeX.
Reproducible and Collaborative Statistical Data Science: Read More [+]
Rules & Requirements
Prerequisites: Statistics 133, Statistics 134, and Statistics 135 (or equivalent)
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week
Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Reproducible and Collaborative Statistical Data Science: Read Less [-]

STAT H195 Special Study for Honors Candidates 1 - 4 Units
Terms offered: Spring 2015, Fall 2014, Fall 2010
Special Study for Honors Candidates: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week
Additional Details
Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Special Study for Honors Candidates: Read Less [-]
STAT 197 Field Study in Statistics 1 - 3 Units
Terms offered: Spring 2017, Fall 2015, Summer 2015 10 Week Session
Supervised experience relevant to specific aspects of statistics in off-campus settings. Individual and/or group meetings with faculty.
Field Study in Statistics: Read More [+]

Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of fieldwork per week
Summer:
6 weeks - 3-8 hours of fieldwork per week
8 weeks - 2-6 hours of fieldwork per week
10 weeks - 1.5-4.5 hours of fieldwork per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Field Study in Statistics: Read Less [-]

STAT 198 Directed Study for Undergraduates 1 - 3 Units
Terms offered: Spring 2018, Spring 2016, Fall 2015
Special tutorial or seminar on selected topics.
Directed Study for Undergraduates: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of directed group study per week
Summer:
6 weeks - 1-4 hours of independent study per week
8 weeks - 1-3 hours of independent study per week
10 weeks - 1-3 hours of independent study per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Study for Undergraduates: Read Less [-]

STAT 199 Supervised Independent Study and Research 1 - 3 Units
Terms offered: Fall 2019, Fall 2018, Spring 2017
Supervised Independent Study and Research: Read More [+]

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of independent study per week
Summer:
6 weeks - 1-4 hours of independent study per week
8 weeks - 1-3 hours of independent study per week
10 weeks - 1-3 hours of independent study per week

Additional Details

Subject/Course Level: Statistics/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study and Research: Read Less [-]