University of California, Berkeley Department of Statistics

Statistics Undergraduate Major Information 2016

OVERVIEW and LEARNING OUTCOMES of the STATISTICS MAJOR

Statisticians help 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 requisite quantitative and logical skills and experience that they can employ and build on in flexible ways. Majors are expected to master concepts and tools for working with data and to have experience analyzing real data that goes beyond the content of a service course in statistical methods for non-majors. Majors should understand the fundamentals of probability theory, statistical reasoning and inferential methods, statistical computing, statistical modeling and its limitations, and have skill describing, exploring and interpreting data by graphical and other means. Graduates are also expected to learn to communicate effectively.

Students may wish to explore the field of statistics by taking an introductory course such as the new introduction to data science course (Stat/CompSCI/Info C8), Stat 20, 21, or 131A.

CONTACT INFORMATION

Undergraduate Program Website: http://statistics.berkeley.edu/programs/undergrad
Undergraduate Student Services Advisor: Denise Yee | 369 Evans Hall | 510-643-6131 | dyee@berkeley.edu |
Book an appointment at http://denise-yee.youcanbook.me/
Undergraduate Student Services Advising Assistant: Majabean Samadi | 367A Evans Hall | 510-643-2459 |
majabean@berkeley.edu | See Drop-In Advising Schedule
Undergraduate Faculty Advisors: Profs. David Aldous, David Brillinger, and Aditya Guntuboyina
See Drop-In Advising Schedule for advising hours
Drop-In Advising Schedule: http://statistics.berkeley.edu/programs/undergrad/advising

MAJOR REQUIREMENTS – ALL courses must be taken for a LETTER GRADE

PREREQUISITES

- Minimum 3.2 UC GPA* in the following math courses AND no lower than a C in:
  - Math 1A Calculus (4 units)
  - Math 1B Calculus (4 units)
  - Math 53 Multivariable Calculus (4 units)
  - Math 54 Linear Algebra and Differential Equations (4 units)

- B- in either Stat 134 or Stat 135
  - Stat 134 is a prerequisite for Stat 135 and MUST be attempted first.
  - No more than one repeated course allowed between Stat 134 and Stat 135

*Math prerequisite GPA is based solely on math courses taken at UC Berkeley or other UC. Students who have taken ALL FOUR prerequisite courses at non-UC institutions, are still required to take at least one Math course at Berkeley to establish a UC GPA. Students may choose Math 54 (B+ required) or Math 110 (B required) or alternative course with consent of the Head Faculty Advisor.

UPPER DIVISION MAJOR REQUIREMENTS (9 courses)

Core Statistics Courses (3 courses):
- Stat 133 Concepts in Computing with Data (3 units)
- Stat 134 Concepts of Probability (3 units)
- Stat 135 Concepts of Statistics (4 units)

Statistics Electives (3 courses*), at least 1 LAB:
Choose from:
- Stat 150 Stochastic Processes (3 units)
- Stat 151A (LAB) Linear Modeling: Theory & Applications (4 units)
- Stat 151B (LAB) Linear Modeling: Theory and Applications (4 units)
- Stat 152 (LAB) Sampling Surveys (4 units)
- Stat 153 (LAB) Introduction to Time Series (4 units)
- Stat 154 (LAB) Modern Statistical Prediction & Machine Learning (4 units)
- Stat 155 Game Theory (3 units)
- Stat 157 Seminar on Topics in Probability and Statistics (3 units)
- Stat 158 (LAB) The Design and Analysis of Experiments (4 units)
- Stat 159 (LAB) Reproducible & Collaborative Statistical Data Science (4 units)
- Graduate courses require Undergraduate Faculty Advisor Approval

Applied Cluster (3 courses*) either
- Math 110 and two courses from the following list: Mathematics 104, 105, 113, 126, 128A, 185 or
- Three upper division courses from a field in which statistics is applied. A list of guidelines and approved applied cluster courses is available online:
  statistics.berkeley.edu/programs/undergrad/approved-cluster-courses

*TEACHING TRACK EMPHASIS. Students interested in teaching statistics and mathematics in middle or high school have a modified upper division course load. In addition to the 3 Core Statistics Courses, 2 Statistics Electives (instead of 3) are required and 4 Math Cluster courses (instead of 3) are required: Math 110, Math 113, Math 151, and either Math 152 or Math 153.

APPLICATION DEADLINES. Students should apply in the semester they are finishing their last prerequisite(s). Applications will be reviewed and approved after all prerequisite grades become available. See the Statistics Undergraduate Major Application for specific application periods.
UC BERKELEY STATISTICS MAJOR COURSE DESCRIPTIONS

**Students who have NOT taken prerequisites are subject to Instructor Drop.**

**Core Statistics Courses**

**Statistics 133: Concepts in Computing with Data** (3 units). This course focuses on statistical computing for data analysis, including how to acquire, clean and organize data, analyze data using computationally intensive statistical methods, and report findings. Students gain experience in computing as a supporting skill for statistical practice and research. They learn how to use existing high-level general purpose software, to implement algorithms from scratch, to express statistical ideas and computations, and they learn about different data technologies and tools, when to use them, and their trade-offs. Students acquire skills in basic numeracy, graphics, modern computationally intensive methods, and simulation. Programming concepts include variables, data types, trees, control flow. Data technology topics include the digital representation of data, regular expressions, relational database management systems, eXtensible Markup Language (XML), Web services for distributed functionality and methods, and Web publication. Extensive written reports are an integral part of the course.

**Statistics 134: Concepts of Probability** (3 units). Prerequisites: One year of calculus. This is an introduction to probability theory, aimed at students who have had at least one year of calculus. The course covers the laws of probability, expectation, conditioning, covariance and correlation, as well as all the standard distributions of discrete and continuous random variables. Functions of random variables - sums, order statistics, and so on - are studied thoroughly, as are limit laws such as the law of large numbers and the central limit theorem, and the standard models: Bernoulli trials, sampling with and without replacement, Poisson process, univariate and bivariate normal. The course serves as preparation for more systematic study of mathematical statistics and stochastic processes.

**Statistics 135: Concepts of Statistics** (4 units). Prerequisites: Math 54 and Stat 134. Stat 133 recommended. This is a comprehensive survey course in statistical theory and methodology, aimed at understanding the fundamental principles of statistical reasoning, achieving proficiency in data analysis, and developing written communications skills. Topics include descriptive statistics and data analysis, fundamental concepts of the theory of estimation and hypothesis testing, and methodology such as sampling, goodness-of-fit testing, analysis of variance, and least squares estimation. The laboratory includes computer-based analysis of data from a variety of fields and requires written reports.

**Upper-division Statistics Elective Courses**

**Statistics 150: Stochastic Processes** (3 units). Prerequisites: Stat 134. This course is especially recommended for students with a strong interest in probability theory or stochastic models, including models in finance, ecology, epidemiology, geophysics and other fields. Topics include random walks, discrete time Markov chains, Poisson processes, continuous time Markov chains, queuing theory, point processes, branching processes, renewal theory, stationary processes, Gaussian processes.

**Statistics 151A-B. Linear Modelling: Theory and Applications** (4 units). Prerequisites: Stat 135. Stat 133 recommended. This course is especially recommended for students with an interest in economics, social science, or statistical models and data analysis more generally. 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.

**Statistics 152 Sampling Surveys** (4 units). Prerequisites: Stat 134. Stat 133 and 135 recommended. This course is especially recommended for students with an interest in social science, marketing, and data collection more generally. Topics include theory and practice of sampling from finite populations; simple random, stratified, cluster, and double sampling; sampling with unequal probabilities; properties of various estimators including ratio, regression, and difference estimators; and error estimation for complex samples.

**Statistics 153 Introduction to Time Series** (4 units). Prerequisites: Stat 134 or consent of instructor. Stat 133 or 135 recommended. This course is especially recommended for students with an interest in physical science, communication and information theory, economics, finance, or actuarial work. An introduction to time series analysis in the time domain and spectral domain. Topics include estimation of trends and seasonal effects, autoregressive moving average models, forecasting, indicators, harmonic analysis, spectra.

**Statistics 154 Modern Statistical Prediction and Machine Learning** (4 units). Prerequisites: Mathematics 53 and 54 or equivalents; Statistics 135 or equivalent; experience with some programming language. Mathematics 55 or equivalent exposure to counting arguments is recommended but not required. Theory and practice of statistical prediction. Contemporary methods as extensions of classical methods. Topics: optimal prediction rules, the curse of dimensionality, empirical risk, linear regression and classification, basis expansions, regularization, splines, the bootstrap, model selection, classification and regression trees, boosting, support vector machines. Computational efficiency versus predictive performance. Emphasis on experience with real data and assessing statistical assumptions.

**Statistics 155 Game Theory** (3 units). Prerequisites: Stat 134. This course is especially recommended for students with an interest in mathematics, optimization or strategy, including business decisions. General theory of zero-sum, two-person games, including games in extensive form and continuous games, and illustrated by detailed study of examples.

**Statistics 157 Seminar on Topics in Probability and Statistics** (3 units). Prerequisites: Math 53-54, Stat 134, and consent of instructor. The topic varies considerably from semester to semester. Check with instructor to determine if you have the appropriate foundational knowledge of the topic discussed in that semester. Some Stat 157 courses will require Stat 134 and 135. Some may have additional prerequisites. Topics that have been taught in recent years include, Bayesian Statistics; Probability in the Real World; Statistics and Finance; High-Dimensional Phenomena and Regularization in Statistics; Topics in Stochastic Processes; and Computational Biology and Statistics.

**Statistics 158 The Design and Analysis of Experiments** (4 units). Prerequisites: Statistics 134 and 135 or consent of instructor. Statistics 135 may be taken concurrently. Statistics 133 is recommended. 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.

**Stat 159 Reproducible and Collaborative Statistical Data Science** (4 units). Prerequisites: Statistics 133, Statistics 134, and Statistics 135 (or equivalent). 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.

Lower division and graduate course descriptions can be found in the online Berkeley Academic Guide: guide.berkeley.edu.
Statistics Undergraduate Major Application

WHEN TO SUBMIT APPLICATION:

Students should submit an application in the semester they are completing their last prerequisite(s). For applicants with prerequisites in progress, applications will be reviewed after the grades for all prerequisites are available (2-3 weeks after finals end). Applicants who have completed all prerequisites should schedule an appointment with the Staff Advisor during an upcoming application period.

DEADLINES

Spring 2016: accepted Feb 1 – Mar 24, 2016 and Apr 25 – May 20, 2016
Summer 2016: accepted on a rolling basis with a final deadline of Wednesday, Aug 17, 2016
Fall 2016: accepted Sep 12 – Oct 28, 2016 and Dec 1 – Dec 19, 2016

NO APPLICATIONS THE FIRST 2 WEEKS of instruction or during heavy Tele-BEARS Advising period

HOW TO DECLARE

☐ Fill out the attached Statistics Major Worksheet
  o Obtain from 367 Evans or download from http://statistics.berkeley.edu/programs/undergrad-major
  o Select and list your Applied Cluster Courses. You can review the list of Approved Cluster Courses and guidelines here: http://statistics.berkeley.edu/programs/undergrad/approved-cluster-courses. If a course is not on the list and seems to meet general criteria, see the Undergraduate Faculty Advisor in the Fall semester for approval.

☐ Attach documentation verifying completion of prerequisites and (if applicable):
  o For courses taken at UC Berkeley – attach most recent transcript from BearFacts (unofficial OK)
  o For courses taken at a CA Community College – attach Degree Audit Report showing prerequisite courses with all grades or community college transcript if your Degree Audit Report does not show the courses or each specific grade
  o For courses taken at another 4-year college or a community college outside of California – attach
     ▪ Signed equivalence evaluation form from the Math Department AND
     ▪ Either official transcript from your other college or your UC Berkeley Degree Audit Report showing your relevant transfer coursework and grades

☐ Fill out appropriate Letters & Science form(s) based on single/double major status. Obtain these forms from 367 Evans, outside of 206 Evans, or download at http://ls-advising.berkeley.edu/fp/.
  a. For Statistics single majors only (no double/triple): complete the Petition to Declare Major and Program Planning Worksheet. On the Program Planning Worksheet, list all courses you plan to take each semester beginning with current semester until you plan to graduate. This is a rough plan and we know it is likely to change but it should account for all major, university and college (L&S) requirements.
  b. For double or triple majors within the College of Letters & Science: complete the Double Major Application Packet. Read the instructions thoroughly and fill out every page completely.
  c. For students double majoring with a major outside of the College of Letters & Science: complete the Simultaneous Degree Application Packet instead of the Double Major Application Packet. Read the instructions thoroughly and fill out every page completely.

☐ Turn in all COMPLETED forms to the Undergraduate Staff Advisor or Advising Assistant in 367 Evans. Schedule an appointment at https://denise-yee.youcanbook.me/ or come to Drop-In hours during one of the application periods.
# Sample Program Plans for the Statistics Major

## Sample Statistics Major 4-YEAR Program Plan (no prerequisites completed)

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<tr>
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<th>Fall</th>
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<tbody>
<tr>
<td><strong>YR 1</strong></td>
<td>Math 1A</td>
<td>Math 1B Intro Stat course such as Stat C8+Stat 88, Stat 20 or 21</td>
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<tr>
<td><strong>YR 2</strong></td>
<td>Math 53 (cluster prerequisite, if applicable)</td>
<td>Math 54 Cluster #1</td>
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<tr>
<td><strong>YR 3</strong></td>
<td>Stat 133 Stat 134</td>
<td>Stat 135 Cluster #2</td>
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<tr>
<td><strong>YR 4</strong></td>
<td>Stat 15x-level elective Stat 15x-level elective (lab)</td>
<td>Stat 15x-level elective Cluster #3</td>
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## Sample Statistics Major 4-YEAR Program Plan (Math 1A & 1B waived due to AP credit)

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<th>Fall</th>
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<tbody>
<tr>
<td><strong>YR 1</strong></td>
<td>Math 53</td>
<td>Math 54 (cluster prerequisite, if applicable)</td>
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<tr>
<td><strong>YR 2</strong></td>
<td>Stat 134 Declare</td>
<td>Stat 133 Cluster #1</td>
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<tr>
<td><strong>YR 3</strong></td>
<td>Stat 135</td>
<td>Stat 15x-level elective Cluster #2</td>
</tr>
<tr>
<td><strong>YR 4</strong></td>
<td>Stat 15x-level elective (lab)</td>
<td>Stat 15x-level elective Cluster #3</td>
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## Sample Statistics Major 2-YEAR Program Plan for Transfer Students who have completed all math prerequisites at a non-UC

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<tbody>
<tr>
<td><strong>YR 3</strong></td>
<td>Math 53 or 54 Stat 134 Alternative major course</td>
<td>Stat 133 Stat 135</td>
</tr>
<tr>
<td><strong>YR 4</strong></td>
<td>Stat 15x-level elective Stat 15x-level elective (lab) Cluster #1</td>
<td>Stat 15x-level elective Cluster #2 Cluster #3</td>
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</tbody>
</table>

## Sample Statistics Major 2-YEAR Program Plan for Transfer Students who have completed only a year of calculus (Math 1A, 1B)

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<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td><strong>YR 3</strong></td>
<td>Math 53 Math 54 Alternative major course</td>
<td>Stat 133 Stat 134 Cluster #1</td>
</tr>
<tr>
<td><strong>YR 4</strong></td>
<td>Stat 135 Stat 15x-level elective (non-lab) Cluster #2</td>
<td>Stat 15x-level elective Stat 15x-level elective (lab) Cluster #3</td>
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</tbody>
</table>

The sample Program Plans above only include courses required for the Statistics major. A full-time course load in the College of Letters & Science is 13 units so you will have space each semester to round out your schedule with courses that can fulfill other requirements or simply satisfy your intellectual curiosity. You will need to account for all university and college degree requirements, including but not limited to: Reading & Composition, 7 Breadth, minimum 120 units, etc. See degree requirements on the College of Letters & Science website: http://ls-advice.berkeley.edu/requirement/summary.html. Still have questions? Meet with the Statistics Undergraduate Faculty or Staff Advisor to develop a Program Plan that is both feasible and meets your needs. Consider studying abroad or engaging in undergraduate research.
**University of California, Berkeley Department of Statistics**

**Statistics Major Worksheet**

Fill out your NAME, SID, EMAIL, PROPOSED GRADUATION SEMESTER, completed and in-progress LOWER DIV PREREQUISITES and UPPER DIVISION MAJOR REQUIREMENTS, and your proposed CLUSTER OPTION. Attach a copy of your most recent transcript and, if applicable, math evaluation forms verifying course equivalence. See the Math Department if you need a course evaluated prior to submitting this application.

### LOWER DIV PREREQUISITES
Min. 3.2 math GPA with no lower than a C in each

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<tr>
<th>Department</th>
<th>Semester</th>
<th>Grade</th>
<th>GPs (for advisor use)</th>
<th>Notes: (AP exam &amp; score, name of your community college, or approved substitutions)</th>
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<td>Math 1b</td>
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### UPPER DIVISION MAJOR REQUIREMENTS
All of these courses must be taken on a Letter Grade basis.

#### STATISTICS COURSES

- **3 CORE STATISTICS COURSES:**
  - Stat 133
  - Stat 134
  - Stat 135
  - Minimum B- in either 134 or 135 to be eligible to declare

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<tr>
<th>Course &amp; Unit Value</th>
<th>Semester</th>
<th>Grade</th>
<th>GPs (for advisor use)</th>
<th>Instructor</th>
<th>Notes: (AP exam &amp; score, name of your community college, or approved substitutions)</th>
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<td>Stat 135 (4)</td>
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- **STATISTICS ELECTIVES:**
  - 3 Stat 15x-level courses or 2 for Teaching Track
  - at least one must have a lab
  - see Frequently Asked Question for approved graduate courses

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<th>Course &amp; Unit Value</th>
<th>Semester</th>
<th>Grade</th>
<th>GPs (for advisor use)</th>
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<th>Notes: (AP exam &amp; score, name of your community college, or approved substitutions)</th>
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<td>Stat 150 (3)</td>
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<td>Stat 151a (lab) (4)</td>
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#### CLUSTER OPTIONS

- **MATH CLUSTER:** Math 110 and two of these Math courses: 104, 105, 113, 126, 128a, and 185
- **OR TEACHING TRACK:** Math 110, 113, 151 & either Math 152 or 153

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<th>Course &amp; Unit Value</th>
<th>Semester</th>
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**OR**

- **APPLIED CLUSTER:** Three courses in a field in which Statistics is applied. See Approved Cluster Course List or obtain approval from Major Faculty Advisor.

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<th>Course &amp; Unit Value</th>
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Advisor Use: [ ] Add EM __________

Lower div GPA: __________
Return completed application to Undergraduate Advising Staff during Drop-in Hours:
http://statistics.berkeley.edu/programs/undergrad/advising OR
schedule an appointment online here: https://denise-yee.youcanbook.me/

Statistics Department, University of California | Undergraduate Advising
367 Evans Hall, Mail Code #3860 | Berkeley, CA | 94720-3860 | dyee@berkeley.edu | 510-643-6131