

## MATHEMATICS

- BENJAMIN A. BERNSTEIN, Ph.D., Professor of Mathematics.  
 THOMAS BUCK, Ph.D., Professor of Mathematics.  
 GRIFFITH C. EVANS, Ph.D., Professor of Mathematics (Chairman of the Department).  
 JOHN M. McDONALD, Ph.D., Professor of Mathematics.  
 JERZY NEYMAN, Ph.D., Professor of Mathematics and Director of the Statistical Laboratory.  
 GEORGE POLYA, Ph.D., Visiting Professor of Mathematics.  
 MELLEN W. HASKELL, Ph.D., Professor of Mathematics, Emeritus.  
 CHARLES A. NOBLE, Ph.D., Professor of Mathematics, Emeritus.  
 FRANK IRWIN, Ph.D., Associate Professor of Mathematics, Emeritus.  
 DERRICK H. LEHMER, Ph.D., Associate Professor of Mathematics.  
 ♣ HANS LEWY, Ph.D., Associate Professor of Mathematics.  
 SOPHIA LEVY McDONALD, Ph.D., Associate Professor of Mathematics.  
 ♣ CHARLES B. MORREY, JR., Ph.D., Associate Professor of Mathematics.  
 EDWARD B. ROESSLER, Ph.D., Associate Professor of Mathematics.  
 PAULINE SPERRY, Ph.D., Associate Professor of Mathematics.  
 \* BING C. WONG, Ph.D., Associate Professor of Mathematics.  
 ALBERT C. BURDETTE, Ph.D., Assistant Professor of Mathematics.  
 ALFRED L. FOSTER, Ph.D., Assistant Professor of Mathematics.  
 ♡ ELMER C. GOLDSWORTHY, Ph.D., Assistant Professor of Mathematics.  
 ♣ ANTHONY P. MORSE, Ph.D., Assistant Professor of Mathematics.  
 RAPHAEL M. ROBINSON, Ph.D., Assistant Professor of Mathematics.  
 RAYMOND H. SCIOBERETI, Ph.D., Assistant Professor of Mathematics.  
 ARTHUR R. WILLIAMS, Ph.D., Assistant Professor of Mathematics.  
 ♡ FRANCIS W. DRESCH, Ph.D., Instructor in Mathematics.  
 SAMUEL A. SCHAAF, Ph.D., Instructor in Mathematics.  
 LEE H. SWINFORD, Ph.D., Instructor in Mathematics.  
 VIRGINIA W. WAKERLING, Ph.D., Instructor in Mathematics.  
 FRANTISEK WOLF, Ph.D., Instructor in Mathematics.
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- ♣ MARK W. EUDEY, A.B., Lecturer in Mathematics.  
 EVELYN FIX, M.A., Lecturer in Mathematics.  
 ALFRED TARSKI, Ph.D., Lecturer in Mathematics.  
 LEWIS F. WALTON, Ph.D., Lecturer in Mathematics.
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- GEORGE P. ADAMS, Ph.D., Mills Prof. of Mental and Moral Philosophy and Civil Polity.  
 DAVID D. BOYDEN, M.A., Assistant Professor of Music.  
 FRANCIS J. CARMODY, Ph.D., Associate Professor of French.

\* Absent on leave, 1944-1945.

♣ On leave for civilian war work.

♡ On leave for duty in the armed forces.

- CLINTON C. CONRAD, Ph.D., Lecturer in Education.  
 R. TRACY CRAWFORD, Ph.D., Professor of Astronomy.  
 WILLIAM R. DENNES, D.Phil., Professor of Philosophy.  
 PAUL MARHENKE, Ph.D., Associate Professor of Philosophy.

*Letters and Science List.*—All undergraduate courses in mathematics except course 107 are included in the Letters and Science List of Courses. For regulations governing this list, see page 76.

*Departmental Major Adviser:* Mr. LEHMER.

*Preparation for the Major Adviser:* Mr. FOSTER.

Before taking the upper division courses for the major, the student should have a basis of knowledge equivalent to courses, C, E, 9, 8, 3A-3B, 4A-4B. It is desirable, therefore, that he should have completed in high school two years of algebra, plane and solid geometry, and trigonometry, in order to anticipate as much of this work as possible.

*The Major.*—In his 24 units of upper division work required for the major in mathematics, the student is supposed to acquire competence in algebra, analysis, and geometry. The courses designed for this purpose are 111A-111B, 112A-112B, 119A-119B, in each of which at least 3 units should be taken.

Subject to this requirement of competence, and with the approval of the adviser, the student is at liberty to take theoretical courses in physics, astronomy, or other sciences as part of his major in mathematics. Course 201 forms a desirable part of the program for senior students with facility for mathematics, as well as the courses listed in the upper division. Special attention is directed to course 199.

The students' attention is also directed to the possibility of making group majors with other departments. Such majors will be welcomed not only with the departments of the physical sciences, but also with some of the social sciences and philosophy.

*Colleges of Engineering and Chemistry.*—The minimum requirements for admission to the freshman course (3A-3B, or 3) are two years of high school algebra or Mathematics 1, plane geometry, and plane trigonometry. Prospective engineering students are urged, however, to add a half-year of solid geometry to this minimum preparation.

*School of Business Administration.*—Mathematics 2, Mathematics of Business and Finance, is a prerequisite for students in the School of Business Administration. As an alternative, however, Mathematics 11A-11B, Analytic Geometry and Calculus, or Mathematics 3A-3B, Plane Analytic Geometry and Calculus, may be substituted, if students wish to continue with advanced mathematics.

*Statistics.*—Students who plan to pursue graduate work in the theory of statistics should consult with Mr. Neyman as early as the beginning of the junior year.

## LOWER DIVISION COURSES

- C. Trigonometry. (3) I and II. Tu Th S, 8, 9, 11. The STAFF  
 Prerequisite: plane geometry; one and one-half years of high school algebra, or course 1.  
 Course C includes plane trigonometry and spherical right triangles.
- E. Solid Geometry. (2) I and II. Tu Th, 12. The STAFF
1. Intermediate Algebra. (3) I and II. Tu Th S, 8; M Tu W Th F, 8, 12. The STAFF  
 Prerequisite: one year of high school algebra. One and one-half years of

high school algebra is advised. Students who need extra drill will be asked to attend the sections which meet five days a week. Not open to students who have received credit for two years of high school algebra, or course 3A or 8.

2. Mathematics of Finance and Business. (3) I and II. Tu Th S, 9; M W F, 2.  
The STAFF  
Prerequisite: two years of high school algebra or course 1. Prescribed in the School of Business Administration. Not open to students who have completed or are taking Mechanical Engineering 120.
3. Plane Analytic Geometry and Calculus. (6) II. M Tu W Th F S, 9.  
Prerequisite: same as for 3A-3B. Mr. SCIOBERETH
- †3A. Analytic Geometry. (3) I and II. M W F, 9, 10, 11, 12. The STAFF  
Prerequisite: two years of high school algebra or course 1; plane geometry, plane trigonometry. Students who do not meet these prerequisites may demonstrate their fitness by passing an examination in these topics.
- 3B. Calculus. (3) I and II. M W F, 10, 11, 12. The STAFF  
Prerequisite: course 3A or course 11A-11B.
- 4A-4B. Solid Analytic Geometry and Calculus. (3-3) Yr. Beginning either term. I and II: 4A, M W F, 9, 10; 4B, M W F, 9, 10. The STAFF  
Prerequisite: course 3A-3B.
4. Solid Analytic Geometry and Calculus. (6) I and II. M Tu W Th F S, 9. The STAFF  
Prerequisite: same as for 4A-4B.
8. College Algebra. (3) I and II. Tu Th S, 10. Mr. BERNSTEIN  
Prerequisite: two years of algebra in the high school (or course 1) and course 3A.  
Determinants, equations of third and fourth degrees, theory of equations.
9. Introduction to Projective Geometry. (3) II. Tu Th S, 9. Miss SPERRY  
(Formerly numbered 6.)  
Prerequisite: course E or high school solid geometry, and course 8 or its equivalent.
10. Spherical Trigonometry. Topics in Algebra. (2) I and II. M W, 1. The STAFF  
Prerequisite: one and one-half years of high school algebra or course 1 and plane trigonometry. Students who are taking or have taken Astronomy 8 will receive only one unit credit for Mathematics 10.
- \*11A-11B. Analytic Geometry and Calculus. (3-3) Yr. M W F, 12. ———  
Prerequisite: one and one-half years of high school algebra, or course 1; plane geometry; plane trigonometry.  
Completion of this year course will satisfy the prerequisite requirement for course 3B.
12. Introduction to Statistics. (3) II. Tu Th S, 10. ———  
Prerequisite: two years of high school algebra or course 1.

\* Not to be given, 1944-1945.

† Students who are enrolled in Navy programs, and are prepared for Courses 3A, 3B, 4A, 14A, etc., may enroll in them and thus accelerate their progress. They should, however, also enroll in Course 10, since that material is also required. A student who completes courses 10, 14A, 14B, satisfies the requirements of the Navy program.

- 14A-14B. Calculus and Advanced Calculus. (5-5) Yr. M Tu W Th F, 8, 9.  
Mr. BUCK, Mr. SCIOBERETH

During the emergency period, 14A and 14B are respectively consolidations of 4A, 110A and 4B, 110B.

## UPPER DIVISION COURSES

- 101A-101B. Elementary Mathematics for Advanced Students. (3-3) Yr.  
Mrs. McDONALD, Mr. TARSKI  
I: (Tarski), M W F, 2. II: (McDonald), M W F, 11.  
Prerequisite: courses 4A-4B, 8, 9 (formerly 6). (101A is not prerequisite to 101B.)  
Designed for students who are preparing to teach mathematics in secondary schools.
107. Mathematics in Secondary Schools. (2) I. M W, 11. Mrs. McDONALD  
For seniors and graduate students. This course will be accepted in partial satisfaction of the requirement in education for the Certificate of Completion of the Teacher-Training Curriculum.
- 110A-110B. Advanced Calculus. (2-2) Yr. Tu Th, 9, 10.  
Mr. BUCK, Mr. ROESSLER, Mr. WILLIAMS  
Prerequisite: course 4A-4B. Primarily for students in engineering.  
Conjugate functions, hyperbolic functions, Fourier series, differential equations.
110. Advanced Calculus. Double Course. (4) I. Tu W Th F, 8. Mr. BURDETTE  
Prerequisite: same as for 110A-110B.
- 111A. Algebra. (3) I. M W F, 12. Mr. SWINFORD  
Prerequisite: courses 4A-4B, 8.  
Linear dependence, matrices, invariants, quadratic forms.
- 111B. Algebra. (3) II. M W F, 12. Mr. FOSTER  
Prerequisite: courses 4A-4B, 8. 111B may precede 111A if this order is unavoidable.  
Groups, theory of equations, introduction to Galois theory.
- 112A. Advanced Analytic Geometry of the Plane. (3) I. Tu Th S, 10. Miss SPERRY  
Prerequisite: courses 4A-4B, 8, 9 (formerly 6), 111A. Course 112A may be taken concurrently with course 111A.
- 112B. Introduction to Metric Differential Geometry. (3) II. Tu Th S, 10. Miss SPERRY  
Prerequisite: courses 4A-4B, 9, 111A. Course 112B may precede 112A if that order is unavoidable.
- 115A-115B. Introduction to the Theory of Numbers. (3-3) Yr. M W F, 1. Mr. LEHMER, M. SWINFORD  
Prerequisite: course 8; 115A is not prerequisite to 115B.  
Divisibility, congruences, number systems.
116. Exterior Ballistics. (3) II. M W F, 2. Mr. LEHMER, Mr. SWINFORD  
Prerequisite: course 4A-4B.
- 119A-119B. Differential Equations. (3-3) Yr. M W F, 8, 9.  
Mr. EVANS, Mr. ROBINSON, Mr. SCHAAF, Mrs. WAKERLING  
Prerequisite: course 4C-4H, or 4A-4B, with honor grades; or 14A-14B; or 4A-4B and 110A-110B; or permission of the instructor.

120A-120B. Probability. (See under Statistics.)

\* 121. Mathematical Introduction to Economics. (3) II. Tu Th S, 11.  
Prerequisite: course 4A-4B. Mr. EVANS  
Monopoly, competition, theory of dimension, taxation, utility, economic dynamics.

127A-127B. Foundations of Mathematics. (3-3) Yr. Tu Th S, 9.  
127A is not prerequisite to 127B. Mr. BERNSTEIN  
Mathematical development of logic, and the logic of algebra and geometry.

199. Special Study for Advanced Undergraduates. (1-5) I and II.  
Mr. EVANS in charge  
Investigation of special problems under the direction of members of the department. In particular, this course offers an opportunity to students with facility for mathematics to anticipate some of the advanced courses by individual study.

## TEACHERS' COURSE

\*307. Coördination of Teaching of Mathematics. (2) I and II, W, 4-6.  
Group discussion. Mrs. McDONALD

## GRADUATE COURSES

Concerning conditions for admission to graduate courses see page 130.

201A-201B. Function Theory. (3-3) Yr. Tu Th S, 9. Mr. ROBINSON, Mr. WOLF  
Prerequisite: course 119A-119B.  
Introduction to real and complex variable.  
Students with facility for mathematics may well take this course in the senior, undergraduate year.

205A-205B. Theory of Functions of a Complex Variable. (3-3) Yr. Tu Th S, 9.  
Mr. McDONALD, Mr. TARSKI  
Prerequisite: course 201A-201B.

†210A-210B. Theory of Functions of a Real Variable. (3-3) Yr.  
Prerequisite: course 201A-201B. Mr. EVANS, Mr. TARSKI

220A-220B. Differential Equations. (3-3) Yr. M W F, 10. Mr. BUCK  
This course presupposes some knowledge of complex and real variable theory.

†240A-240B. Differential Geometry. (3-3) Yr. M W F, 9. Miss SPERRY  
Geometry of 3- and n-spaces, tensor calculus, non-Riemannian geometry.

\*230A-230B. Algebraic Geometry. (3-3) Yr. Mr. WILLIAMS  
N-dimensional, enumerative, and line geometry. Geometric transformations.

†250A-250B. Algebra. (3-3) Yr. Tu Th S, 11. Mr. FOSTER, Mr. TARSKI  
Invariants, groups, Galois theory, fields, modern algebraic theory.

290. Seminars. (2-6) I and II. The STAFF (Mr. EVANS in charge)  
Topics in foundations of mathematics, theory of numbers, numerical calculation, analysis, geometry, algebra, probability and theory of statistics, and in their applications, by means of lectures, and informal conferences

\* Not to be given, 1944-1945.

† To be given if a sufficient number of students enroll.

with members of the staff; work based largely on original memoirs. During 1944-1945 there will be, in particular, lecture seminars on the following subjects, in charge of the persons indicated:

(a) Foundations of mathematics. I, II, Bernstein, Foster; (b) Function geometry and complex variable, I, McDonald; (c) Potential theory with numerical methods. I, II, Swinford, Wolf; (d) Advanced computation for pure and applied mathematics, I, II, Lehmer; (e) Topics in algebra and metamathematics, I, II, Tarski.

295. Individual Research Leading to Higher Degree. (2-6) I and II.  
The STAFF (Mr. EVANS in charge)

Mathematical Colloquium. No credit. I and II. Th, 2.  
The STAFF (Mr. LEHMER in charge)

Meetings for the presentation of original work by members of the staff and graduate students.

## Statistics

## UPPER DIVISION COURSES

120A-120B. Elementary Theory of Probability. (3-3) Yr. Tu Th S, 8. ———  
Prerequisite: course 4A-4B.

Definitions and fundamental theorems. Empirical Law of large numbers and possibility of applications. Illustrations from Mendelian theory of heredity. Mathematical law of large numbers and theorems of Laplace and Bienaymé-Tshebysheff. Theory of least squares. Applications.

122. Descriptive Statistics. (4) II. Miss FIX  
Prerequisite: courses 4A-4B, 120A.

Lectures, Tu Th, 10; laboratory, M, 2-6, S, 9-11.  
Collective and individual characters. Mathematical statistics as theory of collective characters. Means. Measures of dispersion. Frequency curves. Moments. Sheppard's corrections. Pearson curves. Curves of Charlier. Methods of fitting. Stochastic explanation of various distributions. Multivariate distributions. Static regressions and correlations. Applications.

## GRADUATE COURSES

NOTE.—Courses 261, 262, and 263 are intended to introduce the student to practical work in various fields of application. It is intended to give two of these courses each year, each course extending over one term only. The character of the audience of the course given in fall term may justify the extension of the course for the spring term also, in which case there will be only one applicational course given during that particular year. Apart from four hours of supervised practical work, connected with courses 261-264 the students attending these courses will be able to use the laboratory at other times.

Students who are doing research problems in experimental sciences may register in courses 261-264 without the specified prerequisite, with the permission of the instructor.

The laboratory will be open to graduate students for research.

260A-260B. Probability, Second Course. (5-5) Yr. Mr. NEYMAN, Mr. POLYA  
Prerequisite: courses 120A-120B, 201A-201B.  
Lectures, M W F, 9; laboratory, W F, 2-5.

Probability laws and their transformations. Statistical hypotheses and their tests. Power of a test. Lambda criterion. Linear hypotheses. Generalized theorem of Laplace and Chi-square test. Uniformly most powerful tests. Unbiased tests. Tests unbiased in the limit. Problems of estimation. Confidence intervals.

NOTE: Courses 260A or 260B may be taken without laboratory work for 3 units credit.

Berkeley 1944-45

261. Statistical Problems in Experimentation. (3) I. Tu Th, 2-5.

Prerequisite: course 120A-120B.

Statistical hypotheses and their tests. Power function as a basis for a choice between alternative tests. Mathematical models of experimental problems. Theorems of Liapounoff and Kozakiewicz. Linear hypotheses. Chi-square tests and their power. Random and systematic designs. Complex experiments.

- †264. Statistical Problems of Mass Production and Control of Quality. (3) II. W F, evenings.

Mr. NEYMAN and Assistant

Lectures and laboratory work on Wednesday and Friday evenings, hours to be arranged.

Prerequisite: for mathematical students, course 120A-120B; students specializing in subjects other than mathematics and engineers working in industry are expected to be familiar with college algebra and calculus.

Variability in manufactured products. Conception of controlled accuracy of analyses and of controlled variability of manufactured products. Sampling designed to protect interests of manufacturer and of consumer. Estimation of percentage of defective. Causes of defects. Design of experiments and probability of success.

- †265A-265B. Advanced Probability. (3-3) Yr. M W F, 1.

Prerequisite: courses 120A-120B, 205A-205B, 210A-210B; course 260 is not a prerequisite, but students familiar with its contents are likely to appreciate more the various points discussed in 265A-265B.

Probability laws and their general properties. Mean values. Characteristic functions. Convergence "in probability." Normal distribution and central limit theorem. Liapounoff's theorem. Markoff chains and random processes. Applications to physics and biology. Theorems of S. Bernstein and Kozakiewicz.

- 290s. Statistical Seminar. (2-6) I and II. Mr. NEYMAN, Mr. POLYA

295. See page 275.

† To be given if a sufficient number of students enroll.

## MEDICO-MILITARY SCIENCE AND TACTICS

A division of the Medical School

For the duration, courses in Medico-Military Science and Tactics, formerly elective for students in the Medical School, will be discontinued.

The material covered in the courses of the Division will be included in lectures for (1) students in the Army Specialized Training Program and (2) those who have a commission in the Medical Administrative Corps, United States Army. No credit will be given. Lectures will be under the supervision of Herbert C. Gibner, Colonel, Medical Corps, Commandant SCU 3928, and Professor of Military Science and Tactics.

121A-121B. Medico-Military Science and Tactics (first year).

For courses 122A-122B, 123A-123B, and 124A-124B, see the Announcement of the Medical School.

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