1914-15

DEPARTMENT OF MATHEMATICS.

HARRY W. TYLER, PH.D.
Walker Professor of Mathematics.

DANA P. BARTLETT, S.B.
Professor of Mathematics.

FREDERICK S. WOODS, PH.D.
Professor of Mathematics.

FREDERICK H. BAILEY, A.M.
Professor of Mathematics.

EDWIN B. WILSON, PH.D.
Professor of Mathematics.

NATHAN R. GEORGE, JR., A.M.
Associate Professor of Mathematics.

LEONARD M. PASSANO, A.B.
Associate Professor of Mathematics.

CLARENCE L. E. MOORE, PH.D.
Assistant Professor of Mathematics.

Instructors.

HENRY B. PHILLIPS, PH.D.   FRANK L. HITCHCOCK, PH.D.
JOSEPH LIPKA, PH.D.   EDWARD KIRCHER, PH.D.

Great importance is attached to the study of Mathematics, both as a means of general education and as a necessary basis for further instruction in the engineering and other Courses. Nearly all students pursuing regular courses study Mathematics throughout their first two years, beginning with a course in Plane Trigonometry, and a general course in Algebra, Analytic Geometry, and Calculus which begins in the first term of the first year and continues to the middle or end of the second year, or in some Courses to the middle of the third year. This consecutive course in Mathematics includes work formerly divided somewhat arbitrarily into Algebra, Analytic Geometry, Differential Calculus, Integral Calculus, and Differ-

ential Equations. The sub-titles retained in parentheses indicate merely the approximate distribution under the present plan. Care is taken to present both underlying principles and a great variety of concrete applications, the latter connecting the mathematical instruction closely with the professional studies. The instruction is given mainly by recitations in small sections, the number of the students in a section being rarely permitted to exceed twenty. Students having time and interest for the study of Mathematics beyond the prescribed limits are offered opportunity for more advanced work.

M10. PLANE TRIGONOMETRY.

Professors Bartlett, George,[1] Passano, Moore; Messrs. Phillips, Lipka, Hitchcock, Kircher.

PREPARATION: 1; 2; 5.

A course of two exercises a week during the first term of the first year, covering the following subjects: definitions of the trigonometric functions as ratios; proofs of principal formulas; trigonometric transformations; circular measure of angles; solution of trigonometric equations; inverse trigonometric functions; proofs of formulas of right and of oblique triangles; theory and use of logarithms; and areas and solutions of right and of oblique triangles. The course is fully illustrated by practical problems.

[REQUIRED IN ALL COURSES.]

M11. MATHEMATICS. (Algebra, Elements of Analytic Geometry.)

Professors Tyler,[1] Bartlett, Woods, Bailey, Wilson, George, Passano, Moore; Messrs. Phillips, Lipka, Hitchcock, Kircher.

PREPARATION: 1; 2; 5; M10, taken simultaneously.

A course of two recitations a week during the first term, of the first year covering the following subjects: graphical representation; the polynomial of the first degree in one variable, including the analytic geometry of the straight line: the polynomial of the nth degree in one variable, including the fundamental theorems of the theory of equations; the plotting of certain algebraic functions expressed by surds or fractions; differentiation of the polynomial in one variable, including problems on tangents, normals, maxi-

[1] In charge.

ma and minima, and points of inflection.   The division of topics between M11 and M12 varies from year to year.

[REQUIRED IN ALL COURSES.]

M12. MATHEMATICS.   (Analytic Geometry, Elements of Calculus.)

> *Professors Tyler, Bartlett, Woods, Bailey,*[1] *Wilson, George, Passano, Moore;   Messrs. Phillips, Lipka, Hitchcock, Kircher.*

PREPARATION: M10; M11.

A course of four exercises a week in the second term of the first year in continuation of the preceding and covering the following subjects: the derivation of the equations of curves defined by geometric properties; intersection of curves; differentiation of algebraic functions with applications to geometrical and physical problems; inverse differentiation applied to problems; change of co-ordinate axes; the analytic geometry of curves of the second degree; graphs and derivatives of elementary transcendental functions, and problems; parametric representation; polar co-ordinates; and curvature.   Throughout the course special attention is given to the solution of problems, which are introduced as soon as the requisite theory has been developed.

[REQUIRED IN ALL COURSES.]

M20. SPHERICAL TRIGONOMETRY.

> *Professor Passano;*[1] *Dr. Hitchcock.*

PREPARATION: M10.

This course of ten exercises during the first term of the second year covers the proofs of formulas of right and of oblique spherical triangles, and dependent problems.

[REQUIRED IN COURSE I.]

M21. MATHEMATICS.   (Integral Calculus.)

> *Professors Tyler, Bartlett, Woods,*[1] *Bailey, Wilson, George, Passano, Moore;   Messrs. Phillips, Lipka, Hitchcock, Kircher.*

PREPARATION: M12.

A course of three hours a week during the first term of the second year,

[1] In charge.

MIT 1915

devoted mainly to the integral calculus of functions of one variable and covering the following subjects: infinitesimals and differentials; methods of integration; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of solids of revolution, and other volumes which can be found by a single integration; and mechanical applications to work, attraction, pressure, and centers of gravity and pressure. The division of topics between M21 and M22 varies from year to year.

[REQUIRED IN ALL COURSES.]

M22. MATHEMATICS. (Solid Analytic Geometry, Calculus.)

Professors Tyler, Bartlett,[1] Woods, Bailey, Wilson, George, Passano, Moore; Messrs. Phillips, Lipka, Hitchcock, Kircher.

PREPARATION: M21.

A course of three exercises a week during the second term of the second year, in continuation of course M21, mainly devoted to the study of functions of two variables and covering the following subjects: the elements of solid analytic geometry including a discussion of the plane, the straight line and simple surfaces; partial differentiation; multiple integration, with geometrical applications to areas and volumes, and with mechanical applications to attraction, moments of inertia, and centers of gravity; line integrals and exact differential equations.

[REQUIRED IN ALL COURSES EXCEPT V., OPTIONS 2, 3, VII., XV., OPTION 3.]

M26. THE THEORY OF PROBABILITY AND METHOD OF LEAST SQUARES.

Professor Bartlett.

PREPARATION: M22 taken simultaneously.

This course consists of twenty exercises in the second term, partly lectures and partly recitations, in which, after the fundamental principles that govern the application of the method to the adjustment of observations have been developed, numerous problems are solved illustrating the process of computing the most probable values of the unknown quantities, the determination of the precision measures of the results, and the discussion of the accuracy necessary to be attained in the component measurements of a series in order that the final result may be secured with a prescribed degree of accuracy. The use of the method in the development of empirical equations, the question of the rejection of discordant observations, and the occasional occurrence of special laws of distribution of the errors of

[1] In charge.

observation are also considered. The text-book used is Bartlett, General Principles of the Method of Least Squares.

[REQUIRED IN COURSE VIII., OPTIONS 1, 2.]

M31. MATHEMATICS.   (Differential Equations.)

Professors Bailey,[1] *Wilson, Passano; Dr. Lipka.*

PREPARATION: M22.

A course of three exercises a week during the first term of the third year in continuation of course M22, and covering the following subjects: series; indeterminate forms; complex numbers; differential equations of the first order; singular solutions; linear differential equations; certain partial differential equations; and geometrical and mechanical applications.

Course M36 is recommended to any who anticipate taking graduate work.

[REQUIRED IN COURSES II., XIII., XIII.B.]

M32. MATHEMATICS.   (Advanced Calculus, Differential Equations.)

Dr. Phillips.

PREPARATION: M22.

An abridgment of course M35 occupying two hours a week.

[REQUIRED IN COURSE XIV.]

M35. MATHEMATICS.   (Advanced Calculus, Differential Equations.)

Professors Wilson,[1] *Moore; Dr. Lipka.*

PREPARATION: M22.

A course of three exercises a week during the first or second term of the third year, in continuation of course M22, covering the following subjects: Taylor's Formula with applications to approximations in calculation and analysis, complex numbers, vectors, differential equations of the first order, linear differential equations, total and partial differential equations, with numerous applications to geometry and physics.

[REQUIRED IN COURSES VI., VIII., OPTION I.]

[1] In charge.

MIT 1915

M36. MATHEMATICS. (Advanced Calculus and Differential Equations.)

Professor Woods.

PREPARATION: M22.

A course of four hours a week during the first term of the third year, consisting of course M35 with supplementary work.

[REQUIRED IN COURSES VIII., OPTION 2, XIII.A.]

M38. MATHEMATICS. (Advanced Calculus and Differential Equations.)

Professor Woods.

PREPARATION: M36.

This course of thirty exercises in the second term treats the following subjects: line and surface integrals, vectors, functions defined by integrals, the elements of the calculus of variations, differential equations of physics.

[REQUIRED IN COURSE XIII.A.]

M39. MATHEMATICS. (Advanced Calculus and Differential Equations.)

Professor Woods.

PREPARATION: M36.

This course consists of forty-five exercises during the second term, and is an amplification of course M38.

[REQUIRED IN COURSE VIII., OPTION 2.]

M45. FOURIER'S SERIES; LAPLACE'S COEFFICIENTS.

Professor Bailey.

PREPARATION: M31 or M35.

This course consists of a series of lectures and recitations twice a week extending throughout the fourth year. The theory of Fourier's series, Bessel's functions, zonal and spherical harmonics, and their application to the solution of such problems in Physics as can be expressed by certain partial differential equations, are discussed.

[REQUIRED IN COURSE VIII.]

HISTORY OF THE MATHEMATICAL SCIENCES.

Professor Tyler.

This course consists of about ten lectures during each term and forms a part of course 790 on the History of Science, under which title a more detailed description may be found.

[ELECTIVE.]

ELECTIVE ADVANCED COURSES.

In addition to the above subjects, which are required in certain Courses, opportunity for further elective work is given, the topics varying from year to year.

Graduates of the Institute, or of other colleges, desiring to prepare themselves under the conditions of a scientific school for the teaching of Mathematics may advantageously include some or all of these subjects, as well as any of the above not previously taken, in programs for the degree of Master of Science.

The Department will also endeavor in particular to meet the needs of graduate students desiring to engage in mathematical investigation of problems of engineering or applied science.

It is highly desirable that students who intend to take any of the following courses should have previously completed courses M36 and M39.

M51. CURVE TRACING.

Dr. Hitchcock.

PREPARATION: M22.

A course of two exercises a week during the second term, covering the more important facts in regard to plane curves. A large variety of curves are plotted from their equations. Enough time is given to invariants, both scalar and vector, to show the meaning and use of these quantities.

[ELECTIVE.]

MIT 1915

M52. ELEMENTARY THEORY OF THE POTENTIAL FUNCTION.

Dr. Hitchcock.

PREPARATION: M22.

An elementary course during the first term, introducing the student to some of the conceptions underlying modern mathematical physics: electrostatic and gravitational potential, vector fields, and vector potential. The intent of the course is to develop a point of view, rather than to study any part of the subject in detail. The exercises will consist of lectures, problem work, and the study of passages from modern writers.

[ELECTIVE.]

M53. THERMODYNAMICS.

Dr. Phillips.

PREPARATION: M35.

This course will consist of two hours per week during the first term. The general theory of thermodynamics will be developed with special attention to the classic memoirs of Gibbs on the subject.

[ELECTIVE.]

M54. MATHEMATICAL LABORATORY.

Dr. Lipka.

PREPARATION: M22.

A course of two exercises a week throughout the year (either term's work may be taken without the other) for practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences. The course will include: methods for checking the accuracy, and the degree of accuracy, of arithmetic and logarithmic computations; numerical solution of algebraic, transcendental and differential equations; graphical methods in the processes of arithmetic, algebra and the calculus; curve fitting to given data, and the empirical laws connecting these data; the use and principles of construction of instruments employed in calculation, such as slide-rules, arithmometers, planimeters and integraphs; and many kindred topics.

[ELECTIVE.]

M56. ELEMENTS OF THE THEORY OF FUNCTIONS OF A COMPLEX VARIABLE.

Professor Tyler or Professor Woods.

PREPARATION: M31 OR M35.

This course will consist of two exercises a week during the second term.

Emphasis will be placed on the general bearings of the subject in its relation to special branches of Mathematics and their applications, with which the students may be already familiar, and on its significance as an introduction to more advanced subjects.

[ELECTIVE.]

M57. HYDRODYNAMICS.

Professor Wilson.

PREPARATION: M38.

This course consists of twenty lectures during the second term in which the fundamental equations of Hydrodynamics are developed and applied to the solution of particular problems.

[REQUIRED IN COURSES XIII.A., XIII.B.]

M58. ADVANCED GEOMETRY.

Professor Woods.

PREPARATION: M31 or M35.

This course of two hours a week during the second term is intended to extend the knowledge of analytic geometry acquired in the required mathematical courses. Among other subjects, those of Projective Geometry and Non-Euclidean Geometry will be handled.

[ELECTIVE.]

M59. FLUID DYNAMICS, THEORETICAL.

Professor Wilson.

Two hours per week in the first and second terms. The classical mathematical treatment of the motion of fluids, Kirchhoff-Helmholtz discontinuity, cyclic and vortex motion, effect of viscosity and elasticity.

[REQUIRED IN GRADUATE COURSE IN AERONAUTICAL ENGINEERING.]

M63. MATHEMATICS OF WIRELESS TELEGRAPHY.

Professor Wilson.

PREPARATION: M39.

This course consists of two hours per week during the second term, and includes a treatment of the simpler and of some of the more difficult theory of the transmission and reception of electromagnetic energy by ether waves.

[ELECTIVE.]

M65. ANALYTICAL MECHANICS.

Professor Moore.

PREPARATION: M35.

This course of two hours a week throughout the year is mainly a problem course in the kinetics of particles and of rigid bodies in the plane. With the consent of the instructor the course may be taken in either half year alone.

[ELECTIVE.]

M66. DYNAMICS OF RIGID BODIES.

Professor Wilson.

Three hours per week throughout the first and second terms. A complete course of lectures and problems in theoretical mechanics with especial reference to the control of aeroplanes, their oscillations in flight, and gyroscopic effects in turning.

[REQUIRED IN GRADUATE COURSE IN AERONAUTICAL ENGINEERING.]

M67. STATISTICAL METHODS IN THEORETICAL PHYSICS.

Professor Wilson.

PREPARATION: M39.

A course of one lecture per week for the whole year, dealing with general aspects and particular applications of the use in physics of statistical methods, which, beginning with the kinetic theory of gases, have gradually extended over a wide range of phenomena, especially those connected with the second law of thermodynamics.

[ELECTIVE. NOT GIVEN IN 1914–1915.]

400   MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

M69. PARTIAL DIFFERENTIAL EQUATIONS.

Professor Woods.

PREPARATION: M35 or M31.

This course of two hours a week in the first term is an introduction to the theory of partial differential equations, especially of the types which appear in applied mathematics. Particular attention is paid to the solution of equations under given boundary conditions.

[ELECTIVE.]

M71. THE TEACHING OF ELEMENTARY MATHEMATICS.

This course will consist of fifteen or more exercises conducted by various members of the Department and devoted to the discussion of selected questions with special reference to the history and literature of the subject. No specific requirement as to preparation will be made, but the course will be open only to graduate students.

[ELECTIVE.]

References to "first term" and "second term" in course descriptions and a lack of any mention of "third term" indicates semester system