DEPARTMENT OF MATHEMATICS.

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

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Walker Professor of Mathematics.

WEBSTER WELLS, S.B.
Professor of Mathematics.

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Associate Professor of Mathematics.

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

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

Instructors.

NATHAN R. GEORGE, JR., A.M.
LEONARD M. PASSANO, A.B.
BENJAMIN E. CARTER, JR., A.M.
ERNEST A. MILLER, A.M. (absent).
WILFRID E. MACDONALD, A.B.
CLARENCE L. E. MOORE, PH.D.

Great importance is attached to the study of mathematics, both as a means of mental discipline and as a necessary basis for further instruction in the engineering and other Courses. Nearly all regular students pursue mathematical courses for two full years, including algebra, plane trigonometry, plane and solid analytic geometry, differential and integral calculus. Care is taken to present both underlying principles and concrete applications, the latter connecting the mathematical instruction closely with the professional studies. In analytic geometry and calculus the instruction is given in part by lectures, in part by recitations in small sections. The number of students in a recitation section is rarely permitted to exceed twenty-five, thus making possible individ-

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ual treatment of students who require it. Students having time and interest for the study of mathematics beyond the prescribed limits are offered opportunity for more advanced work.

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20. ALGEBRA.

Professors Tyler, Bartlett, Woods,[1] Bailey; Messrs. George, Passano, Carter, MacDonald, Moore.

PREPARATION: 1, 2.

A course of two recitations a week during the first term, covering the following subjects: undetermined coefficients with applications to series and partial fractions; graphical methods in solving equations; permutations and combinations; and the elements of the theory of equations, including the solution of numerical equations by Horner's method.

The text-book is Wells' Advanced Course in Algebra.

[REQUIRED IN ALL COURSES.]

23. PLANE TRIGONOMETRY.

Professors Wells, Woods,[1] Bailey; Messrs. Passano, Carter, MacDonald, Moore.

PREPARATION: 1, 2, 5.

A course of two exercises a week during the first term, covering the following subjects: definitions of the trigonometric functions as ratios; their line representations; proofs of principal formulas; trigonometric transformations; circular measure of angles; 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.

The text-book is Wells' Complete Trigonometry.

[REQUIRED IN ALL COURSES.]

24. SPHERICAL TRIGONOMETRY.

Mr. George.

PREPARATION: 23.

This course of ten exercises covers the proofs of formulas of right and of oblique spherical triangles, and dependent problems. The text-book is Wells' Complete Trigonometry.

[REQUIRED IN COURSES I., XI.]

[1] In charge.

27. ELEMENTS OF ANALYTIC GEOMETRY.

Professors Woods, Bailey.[1]

PREPARATION: 20; 23.

This course, of three exercises a week throughout the second term, includes both plane and solid analytic geometry. The subjects are, in general, the same as those of course 28, but the discussion is necessarily briefer, and is confined to the more fundamental properties of the curves and surfaces. Both rectangular and polar co-ordinates are used. The text-book is Bailey and Woods' Analytic Geometry.

[REQUIRED IN COURSES V., VII.]

28. ANALYTIC GEOMETRY.

Professors Tyler, Bartlett, Woods, Bailey[1]*; Messrs. George, Passano, Carter, MacDonald, Moore.*

PREPARATION: 20; 23.

This course, of four exercises a week throughout the second term, divided between lectures and recitations, includes both plane and solid analytic geometry.

In the plane geometry the equation and the plotting of the corresponding locus is first discussed in general, after which a detailed study of the following topics is made: the straight line; transformation of co-ordinates; the circle; the conic sections as a class of curves; general definitions of tangent, normal, and polar; parabola, ellipse, and hyperbola. Both rectangular and polar co-ordinates are used.

In the solid geometry the subjects are: the interpretation of equations; the plane and the straight line; discussion of central quadric surfaces by means of plane sections.

[REQUIRED IN ALL COURSES EXCEPT V., VII.]

31. ELEMENTS OF DIFFERENTIAL AND INTEGRAL CALCULUS.

Professor Tyler.

PREPARATION: 27.

Three recitations a week during the first term. The course differs from courses 34 and 35 in devoting less attention to complicated problems and in omitting methods and applications which are not essential.

[REQUIRED IN COURSE V., OPTIONS 2, 3, 4.]

34. DIFFERENTIAL CALCULUS.

Professors Osborne, Bartlett,[1] *Woods, Bailey; Messrs. George, Passano, Carter, MacDonald, Moore.*

PREPARATION: 27 or 28.

A course of forty-five exercises in the first term. The aim of this course is to make the student as familiar with the process and meaning of differentiation as he is with the elementary operations of arithmetic; and with this end in

[1] In charge.

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view the exercises consist chiefly of recitations, a comparatively small portion of the time being given to lectures. The formulas or processes of differentiation are deduced by the method of limits, and, after extended practice in obtaining the derivatives of all the common types of expressions, application is made to the expansion of functions in series, the evaluation of indeterminate forms, the partial differentiation of functions of two or more independent variables, the solution of problems in the analytic geometry of plane curves, the determination of maxima and minima values of functions, and to numerous other problems which involve the rate of change of a function with respect to the change in its variable.

[REQUIRED IN ALL COURSES EXCEPT IV., OPTION 3, V., OPTIONS 2, 3, 4, VII., XII.]

35. INTEGRAL CALCULUS.

Professors Tyler, Osborne, Bartlett,[1] *Woods, Bailey; Messrs. George, Passano, Carter, MacDonald, Moore.*

PREPARATION: 34.

A course of forty-five exercises in the second term, partly lectures but chiefly recitations, in continuation of the course in differential calculus. Integration is first defined as representing the reversal of the process of differentiation, and then the fundamental integrals are derived. Integration defined as a summation is then considered, and the relation between the two definitions is demonstrated.

Sufficient time is devoted to the formal process of integration to make the student thoroughly familiar with the fundamental integrals and the methods of reduction of all the common types of expressions. Applications of the integral calculus are taken up in considerable detail, including the determination of the length of curves, the areas of surfaces, both plane and curved, the volumes of solids, moments of inertia, centers of gravity and pressure, and the solution of numerous problems of the sort that are likely to occur in practice. Particular stress is laid upon the proper determination of the limits or constants of integration in single, double, and triple integrals, and upon the ability of the student to express a stated problem in mathematical form; while the aim throughout is to cultivate the power to use the methods of the calculus as a convenient tool and not to have the subject regarded as a merely formal manipulation of symbols.

[REQUIRED IN ALL COURSES EXCEPT IV., OPTION 3, V., OPTIONS 2, 3, AND 4, VII., XII.]

36. ADVANCED CALCULUS AND GEOMETRY.

Professor Woods.

PREPARATION: 39; 35.

This course consists of lectures and recitations four times a week during the first term. Its aim is to give the student such a broad knowledge of the

[1] In charge.

calculus that he may read with advantage the standard treatises on mathematical physics or may begin the study of special topics in pure mathematics.

The subjects treated are as follows: algebraic solid geometry, including the reduction of the general equation of the second order and special properties of the ellipsoid; functions of one variable, including the derivative and the mean value theorems, the definition and properties of definite integrals; application to space curves, including tangent, normal, binormal, osculating plane, curvature, and torsion; functions of two or more variables, including partial differentiation, change of variables, Taylor's theorem, maxima and minima; the differential equation of the first order and the first degree; application to surfaces, including curvature, lines upon surfaces, and curvilinear coördinates; envelopes, including singular solutions of differential equations; double and triple integration; line, surface, and space integrals; infinite series; and the evaluation of standard definite integrals.

[REQUIRED IN COURSES VIII., OPTION 2, XIII.A. ELECTIVE IN COURSE V., OPTION B, XIII., GRADUATE YEAR.]

39. DETERMINANTS.

Mr. Carter.

PREPARATION: 20.

This course consists of fifteen lectures in the first term on the elements of the theory of determinants with applications to the solution of linear equations.

[REQUIRED IN COURSE VIII., OPTION 2.]

42. ELEMENTS OF DIFFERENTIAL EQUATIONS.

Professor Bartlett; Mr. George.

PREPARATION: 35.

This course of ten exercises given in the first term includes the derivation of a differential equation from its complete primitive; the solution of equations of the first order and the first degree; and the solution of linear equations with constant coefficients, the right hand members of which are zero.

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

43. DIFFERENTIAL EQUATIONS.

Professor Osborne; Mr. MacDonald.

PREPARATION: 35.

This course, of forty-five lectures and recitations given in the first term, includes the derivation of differential equations by the elimination of constants; differential equations of the first order, of first degree and of higher degrees; linear differential equations, including linear equations with constant coefficients, and the homogeneous linear equation; special forms of differential equations of higher orders; ordinary simultaneous differential equations;

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linear partial differential equations; and applications to geometry, mechanics, and physics.

[REQUIRED IN COURSES V., OPTION 5, VI., VIII., OPTION 1. COURSE VIII., OPTION 3, ATTENDS THIRTY EXERCISES.]

44. DIFFERENTIAL EQUATIONS.

Professor Woods.

PREPARATION: 36.

This course of thirty exercises in the second term is a continuation of course 36. It differs from course 43 in the fact that the elements have been given in course 36 and some attention is paid to functions defined by differential equations and to partial differential equations of higher order than the first.

[REQUIRED IN COURSES VIII., OPTION 2, XIII.A. ELECTIVE IN COURSES V., OPTION B, XIII., GRADUATE YEAR.]

46. VECTOR ANALYSIS.

Professor Bailey.

PREPARATION: 36, taken simultaneously.

In this course of fifteen lectures in the first term the following subjects are discussed: scalars; vectors; multiplication of vectors by scalars; addition of vectors; scalar and vector products of two or more elements; differentiation of vector expressions; the application of operator ∇ to scalar and vector functions of position in space; and applications to trigonometry, geometry, and mechanics.

[REQUIRED IN COURSE VIII., OPTION 2.]

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

Professor Bailey.

PREPARATION: 43.

This course consists of a series of lectures and recitations twice a week extending throughout the 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., OPTIONS 1, 2.]

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

Professor Bartlett.

PREPARATION: 35.

This course consists of fifteen exercises in the first term, partly lectures and partly recitations, in which, after the fundamental principles that govern the ap-

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plication 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 observation are also considered.

[REQUIRED IN COURSE VIII., OPTIONS 1, 2, XIII.A. ELECTIVE IN COURSE V., OPTION B, GRADUATE YEAR.]

ELECTIVE ADVANCED COURSES.

Professor Woods.

Besides the above subjects, elective advanced courses are offered, the subjects varying from year to year. In 1904–5 the subject is Hydrodynamics.

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