UNDERGRADUATE COURSE SCHEDULES

All undergraduate course schedules given on the following pages will be in effect in 1955–56, unless otherwise indicated.

FIRST YEAR FOR ALL COURSES

THE first-year curricula include fundamental subjects that provide freshmen with a strong foundation for their professional studies. Because these curricula are basic in nature and broad in scope, they can be adapted readily to meet the requirements of any professional course. Thus, although the entering freshman is asked to choose a Course and to plan his first-year program to fulfill the requirements of that Course, he can change his Course at any time before the beginning of the sophomore year with minimum inconvenience. Required subjects missing from the first-year curriculum can be made up in the sophomore and junior years. Entering students have an opportunity to discuss their first-year programs with their Freshman Advisers during Freshman Week-End and throughout the year. The curricula listed below state minimum requirements.

An approved list of first year electives have been established to remove the rigidity of the freshman program and to offer the student the opportunity to broaden his knowledge and increase his perception of the social implications of the arts and sciences. During his first year a student in any course, except IV-A, is expected to take subjects from the list totaling at least six units. Failure to complete this requirement satisfactorily will mean the addition of six units to his later program. A student in Course IV-A is required to take 16 units of subjects from the approved list of electives, and failure to complete any part of this requirement will mean the addition of a corresponding number of units to his later program.

With the consent of his advisor a first-year student may take other subjects for which he is qualified in addition to the elective requirement. Most of such subjects will require more than six hours, and many will have final examinations. If such additional subjects are required in the student's later course, satisfactory completion of them in his freshman year will allow him later elective time.

FIRST YEAR FOR COURSES IN THE SCHOOLS OF ENGINEERING, SCIENCE, HUMANITIES AND SOCIAL STUDIES, AND INDUSTRIAL MANAGEMENT

(All courses except IV-A)

First Term	5·01	Chemistry, General	6–5	*Second Term*	5·02	Chemistry, General	6–5
	8·01	Physics	5–6		8·02	Physics	5–6
	H11	Western Civilization, Found.	3–5		H12	Western Civilization, Found.	3–5
	M11	Calculus	3–6		M12	Calculus	3–6
	MS11	Military Science	3–0		MS12	Military Science	3–0
		Elective Subject*	0 to 6			Elective Subject*	0 to 6
			42 to 48				42 to 48

* Elective subjects totaling at least 6 units for the academic year are to be selected from the list of Approved First-Year Elective Subjects below; the required 6 units may be taken in either term.

The Department of Aeronautical Engineering (Course XVI) and the Department of Naval Architecture and Marine Engineering (Course XIII) *require* Descriptive Geometry D12, 4–2, as the elective subject. The other Courses in the Schools of Engineering and of Industrial Management *recommend* a Graphics subject as the elective subject.

FIRST YEAR FOR THE SCHOOL OF ARCHITECTURE AND PLANNING

(Course IV-A)

First Term	8·01	Physics	5–6	*Second Term*	8·02	Physics	5–6
	D11	Engineering Drawing	4–2		D12	Descriptive Geometry	4–2
	H11	Western Civilization, Found.	3–5		H12	Western Civilization, Found.	3–5
	M11	Calculus	3–6		M12	Calculus	3–6
	MS11	Military Science	3–0		MS12	Military Science	3–0
		Elective Subject‡	5 to 11			Elective Subject‡	5 to 11
			42 to 48				42 to 48

‡ Elective subjects totaling at least 16 units for the academic year are to be selected from the list of Approved First-Year Elective Subjects below.

Approved First-Year Elective Subjects†

(See pages 117–171 for Description of Subjects)

First Term	5·01	Chemistry, General (IV-A only)	6–5	*Second Term*	1·001	Conservation of Natural Resources	2–4
	12·00	Earth Science (Geol., Geophys., Geochem.)	2–4		2·70	Creative Thinking	4–2
	19·003	Elem. Meteorology I	3–3		4·00	Structure of the City	2–4
	20·00	Man's Food	3–3		5·02	Chemistry, General (IV-A only)	6–5
	D11	Engineering Drawing (All except IV-A)	4–2		7·00	Perspectives in Life Science	3–3
	D111	Graphics Laboratory I	3–2		19·003	Elem. Meteorology I	3–3
	D12	Descriptive Geometry (All except IV-A)	4–2		D11	Engineering Drawing (All except IV-A)	4–2
	D13	Graphical Processes	2–4		D12	Descriptive Geometry (All except IV-A)	4–2
	E11	English Composition	2–4		D121	Graphics Laboratory II	3–2
	E37	Public Speaking	3–3		D13	Graphical Processes	2–4
	H1	Philosophy & Scientific Method	2–4		D14	Nomography, Elementary	2–4
	L21	Spoken German§	3–3		E11	English Composition	2–4
	L61	Spoken French§	3–3		E38	Public Speaking	3–3
	M100	Elem. Number Theory	2–4		H2	American Character & Inst.	2–4
		Language	¶		L22	Spoken German§	3–3
					L62	SpokenFrench§	3–3
						Language	¶

§ Prerequisite: 3 years of high school French or German, as the case may be, or the equivalent.
† The number of students admitted to any one of these subjects will depend on the facilities available.
¶ Any language subject for which the student is prepared.

XVIII. MATHEMATICS

THE Institute offers exceptional opportunities for the study of mathematics, in both its theoretical aspects and its applications to scientific and engineering work.

The Course outlined is for students who desire to study more mathematics than is contained in the other professional courses. It is well adapted to serve as a preparation for specializing in pure mathematics, in applied mathematics, in mathematical physics, or in engineering fields requiring proficiency in mathematics. The Course also offers excellent opportunities for students who wish to major in mathematical statistics or applied statistics. For most of the students in Course XVIII the curriculum serves as a preparation for further professional training at the graduate level.

Any student who has completed, with a sufficiently high record, the work of the first two years in any of the professional courses in the Institute or their equivalent, may be admitted to the third year in this Course.

The Course leads to the degree of Bachelor of Science in Mathematics.

FIRST YEAR (See page 52)

SECOND YEAR¶

First Term	8·031	Physics	5–5	*Second Term*	8·041	Physics	5–5
	H21	Humanities	3–5		H22	Humanities	3–5
	¶M21	Calculus	3–6		M22	(a) Differential Equations	3–6
	MS21	Military Science	3–0		M32	Statistics, Elementary	3–6
		Language	3–5		M351	(b) Adv. Calculus for Eng.	3–6
		Eng. or Science Elec. Subj. (not Math.)	8		MS22	Military Science	3–0
			46			Language	3–5
							20–27

THIRD YEAR¶

First Term	M351	(a) Adv. Calculus for Eng.	3–6	*Second Term*	M352	(a) Adv. Calculus for Eng.	3–6
	M352	(b) Adv. Calculus for Eng.	3–6			†Humanities	3–5
	*M62	Modern Algebra	3–6			§Elective Subjects	30
		†Humanities	3–5			(b) Science or Eng. Elec. Subj.	9
		§Elective Subjects	21				47
			47				

FOURTH YEAR

First Term	*M831	Analysis	3–9	*Second Term*	*M832	Analysis	3–9
		*Thesis	4			*Thesis	7
		†Humanities	3–5			†Humanities	3–5
		§Elective Subjects	21			§Elective Subjects	21
			45				48

Professional Elective Subjects§

	8·71	Int. Theoretical Physics I	4–8		M342	Modern Statistical Th.	3–6
	8·72	Int. Theoretical Physics II	4–8		M442	Diff. Geometry, Elem.	3–6
	M341	Modern Statistical Th.	3–6		M50	Fund. of Mech. of Continua	3–6
						Any 12-Unit Math. Subject	

XIX. METEOROLOGY

THE Course in Meteorology is designed to provide a broad background in theoretical and applied meteorology. The curriculum includes a number of elective subjects which are intended to comprise an integrated program in a related field of study. Some of the fields in which an effective elective program can be arranged are Chemical Engineering, Instrumentation Mathematics and Physics, Economics, Business Administration and Hydrology. The Course prepares the student for positions in the Weather Bureau, in the meteorological services of airlines, in industries whose operations depend on the weather and in many other organizations in which weather is an important subsidiary factor. The Course also provides a sound background for graduate training for those students who wish to prepare themselves for a career in teaching or research.

Emphasis is placed on the application of basic physical principles to the atmosphere. In the more theoretical subjects, thermodynamics, hydrodynamics and fluid mechanics are developed with special reference to the atmosphere. In synoptic meteorology these theoretical developments are supplemented by empirical and statis-

* See Requirements for Bachelor's Degree, page 48. † See page 50 for list of subjects.
§ Each student must include in his program M442 Diff. Geometry, Elem., 3–6, and at least 36 units of other Professional Elective Subjects.
¶ Students desiring to enter M351 directly after M21 must fulfill all of the conditions specified under the catalogue description of M21 in order to take the "(b)" program of subjects; all others take the "(a)" program.

MATHEMATICS

Subjects M1 to M99

M100. Elementary Number Theory. Elementary theory of whole numbers, including such topics as divisibility, prime and composite numbers, greatest common divisors, solutions of equations in integers, the congruence notation and its application, sums of squares.

M11. Calculus. Fundamental ideas of differential and integral calculus. Differentiation and graphical representation of algebraic functions and of the sine and cosine. Integration of simple algebraic and trigonometric functions. Applications to problems in geometry and mechanics: maxima and minima, velocity and acceleration, plane areas, volumes, arc length, areas of surfaces of revolution, center of gravity, moment of inertia. Analytic geometry of the straight line and the conic sections. Thomas, *Calculus and Analytic Geometry*.

M12. Calculus. Further study of differentiation and integration: trigonometric, inverse trigonometric, exponential, logarithmic and hyperbolic functions. Polar coordinates and parametric representation. Complex numbers. Elementary vector analysis in the plane. Thomas, *Calculus and Analytic Geometry*.

M21. Calculus. Vector velocity and acceleration in plane curvilir ear motion. Three-dimensional analytic geometry. Partial differentiation. Multiple integration. Infinite series. Thomas, *Calculus and Analytic Geometry*.

NOTE

The following procedure has been set up under which highly qualified students may take M351 in the second semester of their sophomore year immediately after they have completed M21, Calculus. Students who wish to take M351 without taking M22 must have some knowledge of the elementary aspects of ordinary differential equations. The Department of Mathematics will conduct an examination during the latter part of the fall semester before the Christmas holidays. This examination, which will not carry Institute credit, will be written and will be based upon Chapter 18 (Differential Equations), pp. 648–671 of the text, *Calculus and Analytic Geometry* by G. B. Thomas, Jr. This material will not be covered in M21, and students who plan to take the examination should, accordingly, study the material on their own. The examination will be open to those students enrolled in M21 who have a record of "B" or above in each of the subjects, M11 and M12.

During the academic year 1955–56 the examination will be given on Saturday, December 3, 1955, from 1:30–3:00 P.M. Students who wish to take the examination should file written application with the Department of Mathematics on or before Monday, November 14, 1955. Special forms for this purpose will be available in the Mathematics Department Office beginning November 7, 1955. Students who do sufficiently well on this examination and who have a record of "B" or above in each of the subjects, M11, M12 and M21, will be considered by the Department of Mathematics to have met the prerequisite for M351. Even though a student meets the prerequisite in this manner, his registration officer, may, in light of the student's total program, require him first to take M22.

M22. Differential Equations. Treatment of ordinary first order differential equations. Introduction to the Laplace transform. Series solutions. Graphical and numerical methods. Separation of variables for partial differential equations. Fourier series and boundary value problems. Betz, Burcham and Ewing, *Differential Equations with Applications*.

M221. Probability and Operations Analysis. Linear differential equations with constant coefficients, Gamma and Beta functions, probability, distribution theory, and expected values. Mathematical theory and techniques particularly appropriate to the application of the scientific method to the solution of business and industrial problems. Emphasis upon the setting up of simple mathematical models and interpretation of analytical results with reference to the primary purpose of aiding in executive decisions.

M32. Elementary Statistics. General survey of the practical application of statistical methods to scientific and engineering problems, covering frequency distributions, moments, precision of measurements, tests of significance, correlation, theory of large and small sampling, analysis of variability, and experimental design.

M333, M334. Applied Statistics Seminar. Primarily for those professionally interested in the field of statistics. Discussion of applications of statistical methods in industry and in analysis of physical and economic data, and of applications in present-day technical journals. (Not offered 1955–56.)

M341, M342. Modern Statistical Theory. Rigorous development of mathematical statistics, including such topics as generalized distribution function, characteristic functions, statistical inference, sampling theory, tests of significance, maximum likelihood statistics, hypothesis testing, theory of estimation, regression theory, introduction to multivariate statistical analysis, and time series analysis. References: S. S. Wilks, *Mathematical Statistics;* H. Cramer, *Mathematical Methods of Statistics;* N. Wiener, *Stationary Time Series*. (M342 not offered 1955–56.)

M351, M352. Advanced Calculus for Engineers (A). Ordinary differential equations; numerical and graphical methods, integration by power series, Legendre and Bessel functions. Laplace transforms. Characteristic value problems; series of orthogonal functions, in particular, Fourier series. Vector analysis; orthogonal curvilinear coordinates. Partial differential equations of mathematical physics. Functions of a complex variable; calculus of residues, conformal mapping. Hildebrand, *Advanced Calculus for Engineers*.

M371, M372. Operations Research. Two-term course designed for fourth year and graduate students who wish to become familiar with the operational methods developed particularly in the armed services during World War II. While as many uses as possible of this scientific method to industrial and business problems will be considered, many of the applications will necessarily have to come from military examples for which they were developed. (M372 not offered 1955–56.)

M381, M382. Theory of Functions (A). Complex numbers, analytic functions. Complex integration, Cauchy's theorem, Cauchy's integral formula, evaluation of definite integrals. Taylor series, Laurent series, partial fractions, infinite products. Riemann's mapping theorem. Analytic continuation. Harmonic functions, solution of Dirichlet's problem, Green's function. Methods in conformal mapping. Linear differential equations, the hyper-geometric and other differential equations. Asymptotic series. Fourier and Laplace transforms.

M39. Methods of Applied Mathematics (A). Operations with matrices and determinants; linear vector spaces; characteristic-value problems. Techniques of calculus of variations; Hamilton's principle and Lagrange's equations; variational principles for deformable bodies; direct and semi-direct methods. Formulation and solution of simple linear difference equations; application of finite-difference methods to approximate solution of partial differential equations. Formulation and treatment of integral equations; Green's function; analytical and numerical methods of solution. Hildebrand, *Methods of Applied Mathematics*.

M411, M412. Numerical Analysis (A). Introduction to the theory and practice of the solution of equations, interpolation, numerical differentiation and integration, and the numerical solution of ordinary differential equations. Selected topics from the following: least-squares methods, smoothing of data, Gaussian quadrature, Tschebycheff approximation, harmonic analysis, approximation by exponentials. Iterative methods for determining characteristic numbers of matrices. Numerical methods for the approximate solution of partial differential equations.

M421, M422. Theoretical Hydromechanics (A). General theory of perfect fluids, fundamental concepts and basic

Mathematics Continued

relations. One-dimensional motion. Two-dimensional motion involving subsonic and supersonic speeds; application of the theory of complex variables. Application of the theory of characteristics to hydrodynamical problems. Three-dimensional motion involving subsonic and supersonic speeds; theory of lifting surfaces. General theory of viscous fluids, fundamental concepts and basic equations, examples of exact solutions. Flow at low Reynolds numbers. Flow at high Reynolds numbers, boundary layer theory. Hydrodynamic stability. Turbulent flows, mixing length theories and statistical theories. Other selected topics of current interest. (Not offered 1955–56.)

M441. PROJECTIVE GEOMETRY. More precise study of curves and surfaces of the second degree than given in M11 and M12. Fundamental notions of projective geometry including Pascal's theorem and the theory of involution. Plücker coordinates, pentaspherical coordinates and non-Euclidean geometry. (Not offered 1955–56.)

M442. ELEMENTARY DIFFERENTIAL GEOMETRY. Plane and space curves. First and second differential form of a surface. Theorems of Meusnier and Euler. Lines of curvature, asymptotic lines, conjugate lines, geodesics. Theorems of Gauss and Codazzi. Developable surfaces, surfaces of rotation, Liouville surfaces. Differential parameters. Problems of mapping. Struik, *Differential Geometry*.

M451, M452. FOURIER SERIES AND INTEGRALS (A.) Elementary theory of Fourier series and integrals as developed along modern lines. Stress on practical applications and development of the necessary analysis from the beginning. (Not offered 1955–56.)

M461. SEMINAR IN MATHEMATICS (A). Reading, consultation and discussion of current mathematical research.

M481, M482. TOPOLOGY (A). Discussion of basic concepts of Topology: topological spaces, metric spaces, closed sets, open sets, connected sets, mappings, general concept of dimension. Demonstration of classical theorems on the topology of Euclidean spaces (Invariance theorem, Jordan theorem, Fixed Point theorem), using the modern methods of mapping into spheres. Applications of two-dimensional topology to function theory and differential equations. Combinatorial topology: Complexes, Betti groups. Proof of the invariance of Betti groups. Duality theorems. Homology theory in topological spaces.

M483. ADVANCED TOPOLOGY (A). Differentiable manifolds. Fibre bundles and their characteristic cohomology classes. Existence of tensor fields with prescribed properties on a differentiable manifold. Imbedding in Euclidean space. Differential forms and de Rham's theorem. Content varying from term to term so that graduate students taking the subject in successive terms may have an introduction to several important phases of topology.

M491, M492. GEOMETRY OF MANIFOLDS (A). Real and complex manifolds, Riemannian and Hermitian manifolds, differential forms, abelian integrals, theta functions, the Riemann-Roch theorem, the generalized Gauss-Bonnet theorem, relations between curvature properties and topological properties, the Hodge theorem, Kahler manifolds; with applications to Riemann surfaces and functions of one and several complex variables. (Not offered 1955–56.)

M50. FUNDAMENTALS OF MECHANICS OF CONTINUA. Analysis of strain, small and large deformations; analysis of stress, stress-strain relations. Equation of continuity, equations of motion. Equation of state, equation of energy, and other thermodynamical considerations. Curvilinear coordinates. Invariance of physical laws under transformation of coordinates. Introduction to tensor calculus in the study of mechanics of continua.

M52. TOPICS IN THE THEORY OF NUMBERS (A). Distribution of primes, including the prime number theorem and a detailed study of the Riemann Zeta-function.

M54. MATHEMATICAL LABORATORY. Practical instruction in numerical, graphical and mechanical calculation and analysis as required in the engineering or applied mathematical sciences, numerical solution of equations; graphical methods; nomography and the construction of graphical charts; curve fitting to empirical data, approximate methods of integration, differentiation and interpolation; use and principles of construction of instruments employed in calculation, and many kindred topics. Lipka, *Graphical and Mechanical Computation*. (Not offered 1955–56.)

M551, M552. FUNCTIONS OF A REAL VARIABLE (A). Theory of the Lebesgue integral with applications to important topics of the theory of functions of a real variable. Connections between real and complex variable theory. Content varying from one year to another, so that graduate students taking the course for successive years can have an introduction to several important chapters of the theory of functions. (Not offered 1955–56.)

M561, M562. FUNCTIONS OF COMPLEX VARIABLES (A). Fuchsian groups. Modular group and its congruence subgroups. Automorphic functions and modular functions. Modular forms. Eisenstein series. Modular functions and Dirichlet series (Hecke's theory). Applications in arithmetic. Modular functions of Siegel. Automorphic functions in n variables. Content varying from one year to another so that graduate students may take the course in successive years. (M562 not offered 1955–56.)

M571, M572. DIFFERENTIAL EQUATIONS (A). Existence theorems and approximation methods. Various aspects of the linear differential equations including boundary problems, solution of certain more common equations by series and integrals, singularities in complex domain. Relationship between integral and differential equations. Schmidt-Fredholm theory of linear integral equations. Non-linear differential equations studied by analytical and topological methods. Singularities of various types with stress on physical interpretation. Poincaré-Liapounoff stability theory. Periodic orbits. Limit cycles. Perturbation methods. (Not offered 1955–56.)

M581, M582. CONTINUOUS GROUPS (A). Elementary properties, subgroups and quotient groups, covering groups, Haar measure, Peter Weyl theorem, Tannaka theorem, Lie groups, Lie algebras of Lie groups, complex groups, complexification of real Lie groups, structure theorem for Lie algebras and Lie groups, topological structure of Lie groups. (Not offered 1955–56.)

M591, M592. PARTIAL DIFFERENTIAL EQUATIONS (A). Geometric approach to first and second order partial differential equations. Characteristics and wave fronts. Stress on second order equations, their classification and physical significance. Boundary value problems, initial value problems. Adjoint equation, variational methods, operational methods. Maximum principle. Applications.

M61. MATHEMATICAL LOGIC (A). Classical calculi of propositions and classes together with their principal applications. Tracing of the main lines of Whitehead and Russell's derivation of classical analysis from logic, emphasizing the marked resemblance between its intermediate stages and various developments in modern algebra. An account of the general theory of logical and mathematical systems, according central places to the theorems of Goedel on incompleteness and the axiom of choice, and to the theory of constructive decidability. (Not offered 1955–56.)

M62. MODERN ALGEBRA. Polynomials, determinants, linear equations, linear transformations, matrices, linear independence, introduction to groups.

M63. ALGEBRA (A). Group theory, including the fundamental theorem on Abelian groups and rotation groups. Elementary theory of rings and fields. Elementary divisors of matrices, reduction to Jordan and other canonical forms. Quadratic and Hermitian forms; symmetric, Hermitian, orthogonal, and unitary matrices. The dual of a vector space, introduction to tensor algebra.

M631. INTEGRAL EQUATIONS (A). Objectives: (1) to show how to express physical problems in the form of integral equations, (2) to provide a treatment of the theory of integral equations, and (3) to describe the methods available for solving such equations. Applications to problems arising in several branches of physics and engineering.

Mathematics Continued

M633. Abstract Algebra (A). Groups with operators and rings of endomorphisms. Theory of fields and their extensions. Introduction to valuation theory. Structure of rings and algebras.

M634. Topics in Algebra (A). Study of algebraic number fields, including such topics as factorization of ideals, splitting and ramification of prime ideals, the group of units, quadratic and cyclotomic fields, general ideal theory and valuation theory. Content varying from year to year so that graduate students may take the subject in successive years.

M641. Tensor Calculus (A). Elements of tensor algebra, followed by analysis of tensor fields, especially of those in which a metric is defined with the aid of a quadratic differential form. Applications to differential geometry, mechanics and physics. (Not offered 1955–56.)

M65. Linear Operators in Hilbert Space (A). Spectral theorem for unbounded operators. Completely continuous operators and integral equations. Groups and semi-groups of operators with applications to ergodic theory. Decomposition and classification of operator algebras. Multiplicity theorem. (Not offered 1955–56.)

M671, M672. Algebraic Functions (A). Closed Riemann surfaces and corresponding algebraic function field. Differentials and abelian integrals. Riemann-Roch's theorem. Abel's theorem and Jacobi's theorem. Unramified extensions and covering Remann surfaces. Algebraic correspondences. Elliptic functions.

M691, M692. Characteristic Value Problems (A). Linear algebra, orthogonal functions, linear integral equations; characteristic value problems of mathematical physics; applications of the calculus of variations; special functions defined by characteristic value problems. Courant-Hilbert, *Methoden der Mathematischen Physik*, Vol. I; or Margenau and Murphy, *The Mathematics of Physics and Chemistry*. (Not offered 1955–56.)

M73. Review of Mathematics. Review of college algebra, trigonometry, elementary calculus, differential equations. (Primarily for selected officers of the U. S. Army, Navy and Coast Guard.)

M761, M762. Theory of Probability (A). Elements of combinatorial analysis. Random variables and expectations Laws of large numbers. The central limit theorem and its applications. Recurrent events and Markov chains. Brownian motion and time series. Prediction theory, information and noise theory. Interconnection between prediction theory and ruin problems with consideration of the practicality of prediction methods when concerned with situations in which the ruin problem is important as in economics. W. Feller, *An Introduction to Mathematical Probability and Its Applications*. (Not offered 1955–56.)

M791, M792. Theoretical and Applied Elasticity (A). Analysis of stress and strain in three dimensions. Stress-strain relations. Minimum principles in elasticity, their theory and application to the approximate solution of boundary value problems. Theory of plane stress and strain, Airy's stress function, use of elements of complex variable theory. Bending of flat plates, linear and non-linear theory. Bending and stretching of thin shells. Elastic stability theory. Elements of the finite deformation theory of elasticity.

M831, M832. Analysis. Dedekind cuts, Bolzano-Weierstrass theorem, Heine-Borel theorem, least upper, greatest lower bounds, Cauchy criteria for convergence, monotone sequences, simple tests for convergence of series, power series. Functions of one variable, continuity, uniform continuity, sequences of functions and uniform convergence, bounded variation and arc length. Derivative, Taylor's theorem, Weierstrass approximation theorem, differentiation of series. Riemann integral, Riemann-Stieltje's integral, interchange of order of limit and integral, fundamental theorem of calculus. Functions of several variables, Jacobians, inverse functions, functional dependence. Multiple integration, change of variables, line integrals, Green's theorem, elementary discussion of surface area. Lebesgue measure and integral in n-dimensional space, convergence theorems, Fubini's theorem, differentiation in 1 dimension. Fourier series, orthogonality and Bessel inequality, simple convergence tests, Cesaro summability. Rudin, *Principles of Mathematical Analysis*.

M833. Analysis. Abstract sets; cardinal and ordinal numbers and their simplest properties. Elements of point set topology; topological and metric spaces, completeness, compactness, connectedness, products of spaces, mappings, continuity, applications to analysis. Linear spaces; norm, operators, completely continuous operators, basic properties of Hilbert space. Abstract measure and integral theory; Borel rings, set functions, absolute continuity, measure, integral. (Not offered 1955–56.)

M851. Potential Theory (A). Potentials arising from electrical and gravitational attraction, fluid flow, heat conduction. Gauss's, Stokes's, and Green's formulas. Laplace's equation. Minimal surfaces, the Dirichlet principle. Harmonic functions and consequences of Green's formulas. Special harmonic functions. Boundary value problems for linear elliptic equations. Application of linear integral equations to solution of boundary value problems. Potential theory on surfaces. Generalized Green's functions. (Not offered 1955–56.)

M90. Mathematical Reading (A). Reading of advanced mathematical treatises under the supervision of some member of the department. Choice of treatise and allotment of time according to individual cases. For graduate students finding it desirable to do advanced work not provided for in the regular subjects. Open to undergraduates only under exceptional circumstances.

MILITARY SCIENCE AND AIR SCIENCE

Subjects MS11 to MS99

MS11, MS12. Military Science. (Required in all Courses.) For students selecting Army: Drill; military organization; military problems and policy of U. S. National Defense Act and ROTC; individual weapons and marksmanship; maps and aerial photographs; combat formations; tactics of the rifle squad; and first aid and hygiene. For students selecting Air Force: Introduction to AFROTC, Introduction to aviation, fundamentals of global geography, international tensions, security organizations, and instruments of national military security; drill.

MS21, MS22. Military Science. (Students must register for one of the following seven units.)

MS212, MS222. Corps of Engineers. Drill; history and traditions of the Corps of Engineers; characteristics of weapons, explosives and demolitions; basic engineer tactics; mine warfare.

MS213, MS223. Signal Corps. Drill, organization and mission of the Signal Corps; communication center fundamentals; basic wire communications; basic radio communications; organization and signal communication practices of infantry, armored, and airborne divisions.

MS214, MS224. Ordnance Corps. Drill; the role of ordnance; automotive materiel; small arms materiel; ammunition materiel; artillery materiel; fire control materiel.

MS215, MS225. Air Science. Careers in the USAF, moral responsibilities of Air Force leaders, introduction to aerial warfare, targets, weapons, aircraft, bases, operations and leadership laboratory.