FIRST YEAR.

All Courses (Except IV and IV-B)

First Term			*Second Term*		
5·01	Chemistry, General	7–4	5·02	Chemistry, General	7–4
8·01	Physics	6–5	8·02	Physics	6–5
D11	Engineering Drawing	6–0	D12	Descriptive Geometry	6–0
E11	English	3–5	E12*	English	3–5
M11	Calculus	3–6	M12	Calculus	3–6
MS11	Military Science	3–0	MS12	Military Science	3–0
PT1	Physical Training	1–0	PT2	Physical Training	1–0
Units of exercise and preparation:		29–20	Units of exercise and preparation:		29–20

FIRST YEAR

COURSES IV and IV-B

First Term			*Second Term*		
4·06	Graphics	6–0	2·232	Structural Mechanics, E1	3–6
4·11	Shades and Shadows	2–0	4·312T	Abstract Design	5–4
4·12	Perspective	2–0	4·712	Architecture I	12–0
4·711	Architecture I	10–1	E12	English	3–5
E·11	English	3–5	L64	French	3–5
L63	French	3–5	MS12	Military Science	3–0
M111	Calculus	3–6	PT2	Physical Training	1–0
MS11	Military Science	3–0	Units of exercise and preparation:		30–20
PT1	Physical Training	1–0			
Units of exercise and preparation:		33–17			

*Options in Writing and Literature, and Scientific Writing and Thought.

SECOND YEAR

In the Second Year, courses are divided roughly into two groups, Engineering and Chemistry. In each group certain basic subjects are common to all courses. In individual courses the remaining units are given to introductory professional subjects. This makes it possible for a student to transfer from one department to another during his second year.

In E21 History, options are offered in European History, American History and History of Thought.

In E22 English and History, options are offered in Biography, Drama, and the History of Thought.

MIT 1935

XVIII. MATHEMATICS

The Institute offers exceptional opportunities for the study of mathematics, either in its theoretical aspects or as applied to scientific and engineering work.

The course outlined is for men who desire to study more mathematics than is contained in the professional courses. It is well adapted to serve as a preparation for specialization in pure mathematics, in mathematical physics, or along lines of engineering requiring proficiency in mathematics.

Any student who has completed satisfactorily the work of the first two years in any of the professional courses in the Institute or their equivalent, provided always that a creditable record has been obtained in mathematics and physics, may be admitted to the third year in this course. Such a student will have to make up the subjects of Algebra and Geometry.

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

MIT 1935

XVIII. MATHEMATICS

FIRST YEAR. See page 78

M

SECOND YEAR

First Term			*Second Term*		
8·03	Physics	5–5	8·04	Physics	6–4
E21	History	3–5	E22	English and History	3–5
M21	Calculus	3–6	M22	Differential Equations	3–6
M23	Algebra and Geometry	3–6	M24	Algebra and Geometry	3–6
MS21	Military Science	3–0	MS22	Military Science	3–0
	Language	3–5		Language	3–5
Units of exercise and preparation:		20–27	Units of exercise and preparation:		21–26

THIRD YEAR

First Term			*Second Term*		
Ec11	Political Economy	3–3	Ec12	Political Economy	3–3
M731	Mechanics	3–6	M62	Modern Algebra	3–6
M77	Vector Analysis	3–5	M732	Mechanics	3–6
M831	Analysis	3–6	M832	Analysis	3–6
	Language	3–5		Language	3–5
	General Study	2–2		General Study	2–2
	Elective	4			
Units of exercise and preparation:		48	Units of exercise and preparation:		17–28

FOURTH YEAR

First Term			*Second Term*		
8·461	Int. to Theoret. Physics	4–8	8·462	Int. Theoret. Physics	4–8
M441	Geometry	3–6	M442	Geometry	3–6
M841	Analysis	3–6	M842	Analysis	3–6
	Elective and Thesis	18		Elective and Thesis	18
Units of exercise and preparation:		48	Units of exercise and preparation:		48

1935

MATHEMATICS

Subjects M1 to M99 (see page 77)

The prerequisites for each subject will be found in the Tabulation.

M1. Algebra, Entrance. For description see entrance requirements.

M3. Solid Geometry, Entrance. For description see entrance requirements.

M4. Trigonometry, Entrance. For description see entrance requirements.

M11. Calculus. An elementary presentation of the fundamental ideas of the calculus; differentiation and integration of algebraic functions; derivatives; differentials; maxima and minima; applications to simple problems in geometry and mechanics, such as the determination of velocity, acceleration, areas, volumes and pressure. A brief discussion of the analytic geometry of the straight line and the conic sections, and the plotting of the curves in rectangular coördinates. Textbook: *Woods and Bailey, Elementary Calculus, Revised Edition.*

M111. Calculus. An elementary course adapted to the needs of students of Architecture.

M12. Calculus. Differentiation and graphical representation of trigonometric, inverse trigonometric, logarithmic and exponential functions, with applications to simple problems of geometry and mechanics, including related velocities, maxima and minima, simple harmonic motion, and curvature; series. Textbook: *Woods and Bailey, Elementary Calculus, Revised Edition.*

M21. Calculus. Partial differentiation; integration of functions of one variable including use of tables; definite integrals; geometrical applications to areas and lengths of plane curves, volumes of solids; mechanical applications to work, pressure, centers of gravity and moments of inertia; double and triple integration with applications to areas, volumes, moments of inertia and centers of gravity. Textbook: *Woods and Bailey, Elementary Calculus, Revised Edition.*

M22. Differential Equations. A treatment of ordinary differential equations including the principal types of first and second order equations, simultaneous equations, and linear equations with constant coefficients. The work is illustrated by numerous applications to geometry, chemistry, physics and mechanics. Textbook: *Phillips, Differential Equations, Third Edition.*

M23, M24. Algebra and Geometry. Determinants, matrices, theory of equations, quadratic forms, conics and quadrics, curvilinear coördinates, elements of analytic and differential geometry.

M31. Differential Equations of Electricity. Deals mainly with the equations which the student of electricity meets in his work. These equations will be discussed from the general point of view, but specific applications will be made to electrical problems. Textbook: *Franklin, Differential Equations for Electrical Engineers.*

M36, M37. Advanced Calculus (A). Fundamental principles, power series, partial differentiation, implicit functions, Gamma and Beta functions, line, surface and space integrals, vectors, ordinary differential equations, Bessel functions, partial differential equations, calculus of variations, elliptic integrals. Textbook: *Woods, Advanced Calculus.*

M381, M382. Advanced Calculus (A). Arranged for students who desire a general course in analysis somewhat more advanced than M36, M37. Among the topics discussed are series, infinite products, definite integrals, functions of a complex variable, asymptotic expansions, Fourier series, differential equations, integral equations, and various transcendental functions of importance in the applications of mathematics. Reference: *Whittaker and Watson, Modern Analysis.*

M41. Differential Equations. Especially adapted to the needs of students in chemical engineering. Textbook: *Hitchcock and Robinson, Differential Equations in Applied Chemistry.*

M441, M442. Geometry. Selected topics from differential and algebraic geometry.

Grad courses see p. 225. Also note the letter "A" MIT 1935

M451, M452. Fourier Series and Integrals (A). The course is devoted to the modern theory of Fourier series and integrals, following lines laid down in Zygmund's "Trigonometrical Series," in Wiener's "Fourier Integral and Its Applications," and in Paley and Wiener's "Harmonic Analysis in the Complex Domain." Among other topics, a considerable amount of space is devoted to almost periodic functions, to Tauberian theorems, and to harmonic analysis as applied to the study of integral functions.

M461, M462. Theory of Numbers (A). Elementary theory, divisibility, properties of numbers, congruences, quadratic residues, linear forms, binary quadratic forms, higher theory of numbers, algebraic domains, ideals. (Not offered in 1935–36.)

M54. Mathematical Laboratory (B). 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; the use and principles of construction of instruments employed in calculation, and many kindred topics. Textbook: *Lipka, Graphical and Mechanical Computation.*

M551, M552. Functions of a Real Variable (A). The first term is primarily devoted to a formulation of the fundamental concepts of infinitesimal analysis more precise than the intuitive treatment in the elementary calculus course. Among the topics treated are real numbers, functions, continuity, derivative, integral, sequences of functions, equi-continuity, uniform convergence, existence theorems, Taylor's series, Fourier series. (Not offered in 1935–36.)

M561, M562. Functions of a Complex Variable (A). A study of the elementary functions for complex values of the variable. Development and application of the fundamental theorems of the analytic function theory. Elements of the theory of the Gamma function, the elliptic functions, and other special functions.

M563. Functions of a Complex Variable (A). An introductory course covering the essential topics of the theory of functions.

M571, M572. Differential Equations (A). Presupposing the formal solution of differential equations as given in undergraduate courses, this subject deals with the following topics: existence theorems of the various types, Cauchy polygons, Picard successive approximations, power series and majorant functions; the properties of functions defined by differential equations, especially linear differential equations; and partial differential equations. An idea of the direction of the subject can be had by consulting Goursat-Hedrick, "A Course in Mathematical Analysis," Volume II, part 2, and Bieberbach, "Differentialgleichungen." (Not offered in 1935–36.)

M581, M582. Continuous Groups (A). A study of the basic concepts of group-theory, such as group, sub-group, invariant sub-group, finite and infinitesimal transformations; one-parameter groups and their applications to differential equations and geometry; r-parameter groups, structure constants, the fundamental theorems of Lie; invariant theories associated with continuous groups; differential invariants and applications to systems of partial differential equations.

M62. Modern Algebra (B). Polynomials, determinants, linear equations, linear transformation, matrices, bilinear, quadratic, and Hermitian forms, introduction to fields and algebras.

M631, M632. Differential Geometry (A). Introduction to differential geometry of curves and surfaces in ordinary space. Differential invariants. Generalization to n dimensional Riemannian manifolds with the aid of the Ricci calculus (Not offered in 1935–36.)

M641, M642. Advanced Differential Geometry (A). This subject, a continuation of M632, contains some of the modern developments in differential geometry, especially those involving tensor calculus, and is particularly useful for students who wish to do research work in this field.

M651, M652. Analytical Mechanics (A). Analytical dynamics of particles and rigid bodies is treated mainly by Lagrange's equations in generalized coördinates and Hamilton's canonical equations. Contact Transformation, the Hamilton-Jacobi theory, the theory of vibrations, and non-holonomic systems are among the topics discussed. (Not offered in 1935–36.)

M661, M662. Algebra of Quantum Theory (A). An introduction to the non-commutative algebras employed by Dirac, Weyl, Heisenberg and others, including the theory of group characters. Slater's matrices, and homopolar valence. Lectures, problems and assigned reading. Familiarity with quantum theory is not prerequisite.

M671, M672. Potential Theory (A). In the first term, the elementary theory. Logarithmic, Newtonian, potential. Potentials of simple and double distribution. Laplace's and Poisson's equations. Harmonic functions. Connection with function theory in the case of two dimensions. Harnack's theorems. Boundary value problems for the circle and the sphere. Poisson's integral. Spherical harmonics. Applications to physics. In the second term, general treatment of the boundary value problems of potential theory. Integral equations. The method of Perron-Remak. Green's function. Applications to conformal mapping. (Not offered in 1935–36.)

M681, M682. Calculus of Variations (A). Extension of the theory of maxima and minima as begun in calculus. The determination of functions, curves or surfaces with given maximum or minimum properties. Applications to geometry and physics; geodesics, minimal surfaces, isoperimetric properties of circle and sphere, Fermat's principle of least time (optics), Hamilton's principle, catenary, brachistochrone. Reference books: *Bolza, Lectures on the Calculus of Variations; Bliss, Calculus of Variations; Goursat, Cours d'Analyse, vol. 2, chapter XXIII.*

M691, M692. Characteristic Value Problems (A). Linear algebra, orthogonal functions, linear integral equations; the characteristic value problems of mathematical physics; applications of the calculus of variations; special functions defined by characteristic value problems. Textbook: *Courant-Hilbert, Methoden der Mathematischen Physik.*

M70. History of Science (B). Same as G1 with two extra units preparation. (Not offered in 1935–36.)

M73. Review of Mathematics. Review of algebra, plane and solid geometry, trigonometry, elementary calculus, differential equations.

M731, M732. Mechanics (B). The fundamental principles of mechanics with applications mainly to the statics and dynamics of rigid bodies.

M75. Mathematics. Practical instruction in numerical, graphical and mechanical calculation and analysis necessary for the solution of problems in interior and exterior ballistics, especially arranged for Army Ordnance officers.

M76. Theory of Probability (A). Permutations and combinations. Elementary principles of the theory of probabilities. Bernoulli's Theorem. Bayes' Theorem. Distributive functions and continuous variables. Averages. Curve fitting. Textbook: *Th. C. Fry, Probability and Its Engineering Uses.*

M77. Vector Analysis (B). A treatment of the vector functions and operations required in theoretical work on electricity. Textbook: *Phillips, Vector Analysis.*

M781, M782. Advanced Geometry (A). Coördinate systems in plane, space and n dimensions. Properties of conics and quadrics. Projective geometry. Non-Euclidean geometry. N-dimensional geometry. Textbook: *Woods, Higher Geometry.* (Not offered in 1935–36.)

M791, M792. Theoretical and Applied Elasticity (A). The fundamental mathematical theory of elasticity in three dimensions; elastic work of deformation, stress equations; stress functions; Mohr's stress diagram; bending of bars, plates, and tubes; instability; vibration of elastic systems; modern theory of strength; plasticity. Principles and methods used in practical engineering problems; prin-

ciples of minimum energy and of virtual velocities; method of deflections, Ritz's method and the application of calculus of variations.

Reference books: *Love, Theory of Elasticity; Föppl, Drang und Zwang; Timoshenko, Theory of Elasticity.*

M831, M832. Analysis (B). The real and complex number system, elementary properties of point sets, limits, continuity, convergence of series, derivative, integral, infinite products, and other notions necessary for a rigorous treatment of calculus. Textbook: *Hardy, Pure Mathematics.*

M841. Analysis (B). Presupposing the preliminary work of M831, M832, this course presents the modern theory of functions of a complex variable, including single valued analytic functions, residues, analytic continuation, conformal representation, and integral functions. Textbook: *Titchmarsh, Theory of Functions.*

M842. Analysis (B). Topics in theory of functions of a real variable, including the theory of measure, Lebesgue integration, Fourier series, and an elementary discussion of the Fourier integral. Textbook: *Titchmarsh, Theory of Functions.*

M90. Mathematical Reading (A). Designed to give the student an opportunity to read advanced mathematical treatises under the supervision of some member of the department. The treatise chosen and the time allowed will be determined by the needs in each particular case. This course is for graduate students who may find it desirable to do advanced work not provided for in the regular courses. Undergraduates may take only under exceptional circumstances.

The following subjects are offered as General Studies. For description see Division of General Studies.

G76. History of Philosophy.

MIT 1935

DEPARTMENT OF MATHEMATICS

The Department of Mathematics offers courses leading to the degrees of Master of Science, Doctor of Philosophy and Doctor of Science.

The course of each student will be arranged in consultation with the Department from subjects mentioned below. A student who is interested in applied mathematics may also be allowed to select subjects offered in other departments. A candidate for the degree of Master of Science will be expected to offer the equivalents of M23, M24 Algebra and Geometry; M831, M832, M841, M842 Analysis; M441, M442 Geometry. Other work of advanced nature and equal time may be substituted for any of these courses.

To obtain the degree of Master of Science the student must elect in each term at least three courses of advanced mathematics or allied subjects, and fill the remainder of his time with other electives and thesis.

For the degree of Doctor of Philosophy the student must fill the requirements stated above for Master of Science with the exception of a master thesis and spend at least an additional year in research.

"A" Subjects. Primarily for Graduates.

First Term			*Second Term*		
M36	Calculus, Adv.	3–6	M37	Calculus, Adv.	3–6
M381	Calculus, Adv.	3–6	M382	Calculus, Adv.	3–6
M451	Four. Ser. & Int. Equations	3–9	M452	Four. Ser. & Int. Equations	3–9
*M461	Theory of Numbers	3–9	*M462	Theory of Numbers	3–9
*M551	Funct. of a Real Variable	3–9	*M552	Funct. of a Real Variable	3–9
M561	Funct. of a Complex Variable	3–9	M562	Funct. of a Complex Variable	3–9
*M571	Differential Equations	3–9	*M572	Differential Equations	3–9
M581	Continuous Groups	3–9	M582	Continuous Groups	3–9
M631	Differential Geometry	3–9	M632	Differential Geometry	3–9
*M641	Differential Geometry, Adv.	3–9	*M642	Differential Geometry, Adv.	3–9
M651	Analytical Mechanics	3–9	M652	Analytical Mechanics	3–9
M661	Algebra of Quant. Theory	3–9	M662	Algebra of Quant. Theory	3–9
M671	Potential Theory	3–9	M672	Potential Theory	3–9
*M681	Calculus of Variations	2–6	*M682	Calculus of Variations	2–6
*M781	Geometry, Adv.	3–9	M76	Theory of Probability	3–9
M791	Theor. and App. Elas.	3–9	*M782	Geometry, Adv.	3–9
M90	Mathematical Reading. Time arr.		M792	Theor. and App. Elas.	3–9
			M90	Mathematical Reading. Time arr.	

*Not offered 1934-35.

"B" Subjects. Open to Graduates and Undergraduates

First Term			*Second Term*		
M26	Least Squares	2–2	M54	Mathematical Lab.	3–6
M62	Modern Algebra	3–6	M732	Mechanics	3–6
M731	Mechanics	3–6	M77	Vector Analysis	3–5
M831	Analysis	3–6	M832	Analysis	3–6
M841	Analysis	3–6	M842	Analysis	3–6
*M70	History of Science	2–4			

*Not offered 1934-35.

This page is from the description of Graduate studies.