Yale University

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Search Yale

Site map | Publications | Yal

Yale College Progra

Fall and Spring

| General | I. Yale College | II. Placement and Acceleration | III. Academic Regulations |

YCPS home

Subjects of Instruction

Subject Abbreviations

Majors in Yale College

Search course information on OCI

Yale College
Publications Office
246 Church Street
New Haven, CT
06510 USA

Home   Subjects of Instruction   Mathematics

Mathematics

(See also Applied Mathematics.)

Mathematics courses
Mathematics department home page

Jack,
Elsewhere I found that 36 "term courses" is the requirement for a BA or BS.
Walter

Director of undergraduate studies: Yair Minsky, 448 DL, 432-4018, yair.minsky@yale

FACULTY OF THE DEPARTMENT OF MATHEMATICS

Professors

Donald Brown, Andrew Casson, Ronald Coifman, Igor Frenkel, Howard Garland, Peter Jones, Ravindran Kannan, Mikhail Kapranov, Bruce Kleiner, Benoit Mand (*Emeritus*), Gregory Margulis, Yair Minsky, Vincent Moncrief, Steven Orszag, D Vladimir Rokhlin, Peter Schultheiss (*Emeritus*), Katepalli Sreenivasan, Gregg Z

J. W. Gibbs Assistant Professors

Dennis Borisov, Tullia Dymarz, Matt Feiszli, Marketa Havlickova, Triet Le, Jaeje Yiqiang Li, Karin Melnick, Hisham Sati, Dapeng Zhan

Adjunct Professors

Michael Frame, Alex Lubotzky

Operations Research Faculty

Eric Denardo

Statistics Faculty

Andrew Barron, Joseph Chang, John Hartigan

Lecturers

Jayadev Athreya, Michael Gurski, Jesse Johnson

M

Both the course offerings and the major in Mathematics reflect the many role: language and tool of the sciences, a cultural phenomenon with a rich historica abstract reasoning. The Mathematics major provides a broad education in var a program flexible enough to accommodate many ranges of interest.

B.A. and B.S. degree programs. The prerequisite for each program is calcu 120a or b, or the equivalent. Each program normally consists of ten term cou numbered 222 and higher, including MATH 480a or b. Each student is expecte linear algebra through the level of MATH 230 or of MATH 250a, and one of M/ Beyond this, it is strongly recommended that the major include courses in rea 301a), in algebra (MATH 350a), and in complex analysis (MATH 310a), togetr provide additional breadth and depth. Students are required to take at least t three of the following five categories: analysis, algebra and number theory, sl mathematics, geometry and topology, and logic and foundations. Specific cou listed below.

Each Mathematics major is urged to acquire additional familiarity with the use courses in Applied Mathematics, Computer Science, Engineering and Applied ! Operations Research, Physics, Statistics, or other departments. In some insta such courses may be counted among the ten courses required for the major ii approval of the director of undergraduate studies.

M

A candidate for the B.S. degree must take at least two advanced term course such as CHEM 328a, 332a, 333b, or PHYS 401a, 402b, in addition to the ten t B.A. degree. Such courses require the approval of the director of undergradua is advised.

Any student interested in pursuing further study in pure mathematics should 310a, 350a, 370b, and either 430b or 435b in his or her program, and should graduate-level courses. Students interested in applications of mathematics sh 301a, 310a, 350a, and a selection of courses among 241a, 242b, 244a, 246a CPSC 440b.

For the Class of 2011 and subsequent classes, courses taken Credit/D/Fail mɛ requirements of the major.

The intensive major. Candidates for a degree with an intensive major in Ma include at least two graduate term courses in the Mathematics department, o study, in their programs. Familiarity with the material of the following courses courses in each category: *algebra:* two courses between MATH 350 and 399; 310a; *algebraic topology:* MATH 301a, 350a; *logic and foundations:* MATH 27

Senior requirement. During the senior year students majoring in Mathemat seminar (MATH 480a or b). Alternatively, with the consent of the director of u qualified students may write a senior essay in MATH 470a or b under the guid and give an oral report to the department. Students wishing to write a senior director of undergraduate studies early in the fall term.

Combined B.S./M.S. Degree Program

Students who, by the end of their senior year, complete the requirements of t in Mathematics will be eligible to receive this degree at their Senior Commenc eight term courses numbered 500 or higher, most of which must be complete (2) a reading knowledge of mathematical literature in a foreign language of ir

research (normally French, German, or Russian); (3) satisfactory performanc
examination.

The master's program is in no sense a substitute for the B.A. or B.S. program
accommodate a very few exceptional students who, by means of accelerated
satisfy the department as to their command of the content of the normal und
spring term of the sophomore year candidates must submit a proposal that fc
achievement by the end of junior year to the director of undergraduate studie
department this proposal will be forwarded to the Dean's Office; see "Simulta
Bachelor's and Master's Degrees" in chapter III under the heading "Special Ar
status and progress will be reviewed before they are permitted to continue in
year.

Students take at least two graduate term courses in the junior year (normally
analysis are the first graduate courses taken). The general oral examination c
from the director of graduate studies and will be accepted in lieu of the usual
Details concerning the requirements for the master's degree may be obtained
graduate studies.

Placement in Courses

The department offers a three-term sequence in calculus, MATH 112a or b, 1:
Students who have not taken calculus at Yale and who wish to enroll in calcul
placement examination found on the department Web page. At the beginning
preregistration session is held in DL 432. To enroll in a calculus course a stud
the placement exam, as well as other pertinent information such as Advancec
the preregistration session. Advisers will be on hand to assist each student in
course.

MATH 112a or b is an introductory course that presupposes basic skills in higl
and trigonometry. Enrolling students are expected to know the basic definitioı
functions, synthetic division, factorization, and elementary area and volume fı
geometry. MATH 115a or b presupposes familiarity with the topics covered in
or b presupposes familiarity with the topics covered in MATH 115a or b.

MATH 230 is an advanced course in linear algebra and introductory analysis fı
strong backgrounds in mathematics. Students who wish to enroll in MATH 23(
instructor of the course. After MATH 115a or b, students with a strong interes
should consider taking MATH 230.

REQUIREMENTS OF THE MAJOR

Prerequisite: MATH 120a or b or equivalent

Number of courses: *B.A.*—10 term courses numbered 222 or higher, incl M
with 2 addtl courses in physical sciences

Distribution of courses: *B.A.*—2 courses in each of 3 categories chosen fro
and number theory, (c) stat and applied math, (d) geometry and topology, (e
B.S.—same, with 2 addtl advanced courses in physical sciences approved by I

Specific courses required: MATH 230 (counts as 2 courses) or MATH 250a
b

Substitution permitted: With DUS permission, certain courses in Applied M

Applied Science, Econ, Operations Research, Physics, Stat

Senior requirement: Senior sem (MATH 480a or b) or, with DUS permission or b) and oral report

Intensive major: 2 grad courses or equivalent independent study counted a

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Introductory Courses: MATH 112a or b, 115a or b, 118a or b, 120a or b, 190

Analysis: MATH 230 (counts as one term course in this category), 246a or b, 310a, 315b, 320a, 325b

Statistics and Applied Mathematics: MATH 235b, 241a, 242b, 244a, 246a or 400a; CPSC 201a or b, 365b, 440b

Algebra and Number Theory: MATH 222a or b, 225a or b, 230 (counts as one category), 244a, 350a, 353a, 360a, 370b, 380a, 381b, 440a

Geometry and Topology: MATH 228a, 290b, 430b, 435b

Logic and Foundations: MATH 270a; PHIL 267a, 268b

Fall Spring 2008/2009

General   I. Yale College   II. Placement and Acceleration   III. Academic Regulations

Home   Subjects of Instruction

Yale College
Publications Office
246 Church Street
New Haven, CT
06510   USA

Mathematics

For courses in other departments that may count toward the major, see the printed Y
director of undergraduate studies.

C

MATH 101b, Geometry of Nature.

TTh 2.30-3.45

QR (27)
Permission of instructor required

Geometric patterns in nature, including classical models of spirals in seashells
symmetry of honeycombs and snowflakes, and the curvature of soap films; th
universe; ways to visualize the fourth dimension; and a brief introduction to fi
Enrollment limited to freshmen and sophomores.

Introductory courses do not count toward the requirements of a major in Math
wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expected to
specific section. In the fall, preregistration is on Tuesday, September 2, 2008,
4 p.m. in 432 DL; in the spring, preregistration is on Monday, January 12, 200
to 4 p.m., also in 432 DL. Students who have not taken calculus at Yale must
online placement exam at www.math.yale.edu/public_html/placement.html be
preregistering. Those who do not preregister may be excluded from sections t

MATH 112a, Calculus of Functions of One Variable I.

MWF 9.25-10.15 LOM 206

MWF 10.30-11.20 LOM 202

MWF 11.35-12.25 LOM 200

TTh 1.00-2.15 LOM 205

TTh 11.35-12.50 WLH 113

TTh 11.35-12.50 ML 104

QR (69)
Permission of instructor required

Limits and their properties. Definitions and some techniques of differentiation
of definite integrals, with applications. Students are instructed in use of the so
Mathematica, which is used in graphical, symbolic, and numerical methods an

no mention of winter term suggests semesters.

some problem sets.
No prior acquaintance with calculus or computing assumed.

Introductory courses do not count toward the requirements of a major wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec specific section. In the fall, preregistration is on Tuesday, September 2 4 p.m. in 432 DL; in the spring, preregistration is on Monday, January to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal online placement exam at www.math.yale.edu/public_html/placement. preregistering. Those who do not preregister may be excluded from se

MATH 112b, Calculus of Functions of One Variable I.

MWF 9.25-10.15

MWF 10.30-11.20

TTh 9.00-10.15

TTh 11.35-12.50

TTh 11.35-12.50

QR (69)
Permission of instructor required

Limits and their properties. Definitions and some techniques of differer of definite integrals, with applications. Students are instructed in use o Mathematica, which is used in graphical, symbolic, and numerical meth some problem sets.
No prior acquaintance with calculus or computing assumed.

Introductory courses do not count toward the requirements of a major wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec specific section. In the fall, preregistration is on Tuesday, September 2 4 p.m. in 432 DL; in the spring, preregistration is on Monday, January to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal online placement exam at www.math.yale.edu/public_html/placement. preregistering. Those who do not preregister may be excluded from se

MATH 115a, Calculus of Functions of One Variable II.

MWF 9.25-10.15 LOM 215

MWF 10.30-11.20 LOM 200

MWF 10.30-11.20 LOM 205

MWF 11.35-12.25 LOM 205

MWF 11.35-12.25 LOM 215

TTh 9.00-10.15 LOM 200

TTh 9.00-10.15 LOM 206

TTh 11.35-12.50 LOM 205

TTh 11.35-12.50 LOM 200

TTh 11.35-12.50 PR140 102A

QR (69)

Permission of instructor required

A continuation of MATH 112a or b. Applications of integration, with son numerical methods. Improper integrals, approximation of functions by series. Exercises involve the software package Mathematica.
After MATH 112a *or* b *or equivalent.*

Introductory courses do not count toward the requirements of a major wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec specific section. In the fall, preregistration is on Tuesday, September 2 4 p.m. in 432 DL; in the spring, preregistration is on Monday, January to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal online placement exam at www.math.yale.edu/public_html/placement. preregistering. Those who do not preregister may be excluded from se

MATH 115b, Calculus of Functions of One Variable II.

MWF 9.25-10.15

MWF 10.30-11.20

MWF 11.35-12.25

TTh 9.00-10.15

TTh 11.35-12.50

TTh 11.35-12.50

QR (69)
Permission of instructor required

A continuation of MATH 112a or b. Applications of integration, with son numerical methods. Improper integrals, approximation of functions by series. Exercises involve the software package Mathematica.
After MATH 112a *or* b *or equivalent.*

Introductory courses do not count toward the requirements of a major wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec specific section. In the fall, preregistration is on Tuesday, September 2 4 p.m. in 432 DL; in the spring, preregistration is on Monday, January to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal online placement exam at www.math.yale.edu/public_html/placement. preregistering. Those who do not preregister may be excluded from se

MATH 118a, Introduction to Functions of Several Variables.

TTh 9.00-10.15 LOM 214

QR (22)
Permission of instructor required

Calculus of several variables and some linear algebra. Intended for stu sciences, especially Economics. Covers parts of MATH 120a or b and M *May not be taken after* MATH 120a *or* b *or* 222a *or* b. *Prerequisite:* MA   ✱

Prereq is M112a or b

Introductory courses do not count toward the requirements of a major wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec specific section. In the fall, preregistration is on Tuesday, September 2 4 p.m. in 432 DL; in the spring, preregistration is on Monday, January to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal online placement exam at www.math.yale.edu/public_html/placement

preregistering. Those who do not preregister may be excluded from se

MATH 118b, Introduction to Functions of Several Variables.

TTh 11.35-12.50

QR (24)
Permission of instructor required

Calculus of several variables and some linear algebra. Intended for stu
sciences, especially Economics. Covers parts of MATH 120a or b and M
May not be taken after MATH 120a *or* b *or* 222a *or* b. *Prerequisite:* MA·

Introductory courses do not count toward the requirements of a major
wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec
specific section. In the fall, preregistration is on Tuesday, September 2
4 p.m. in 432 DL; in the spring, preregistration is on Monday, January
to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal
online placement exam at www.math.yale.edu/public_html/placement.
preregistering. Those who do not preregister may be excluded from se

MATH 120a, Calculus of Functions of Several Variables.

MWF 9.25-10.15 LOM 205

MWF 10.30-11.20 LOM 214

MWF 11.35-12.25 LOM 206

MWF 11.35-12.25 LOM 214

TTh 9.00-10.15 LOM 215

TTh 9.00-10.15 LOM 202

TTh 11.35-12.50 LOM 201

TTh 11.35-12.50 LOM 206

QR (69)
Permission of instructor required

Analytic geometry in three dimensions, using vectors. Real-valued func
variables, partial derivatives, gradient and directional derivatives, level
maxima and minima. Parametrized curves in space, motion in space, li
Multiple integrals, with applications. Divergence and curl. The theorem
Gauss.
After MATH 115a *or* b, *or with permission of instructor.*

Introductory courses do not count toward the requirements of a major
wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec
specific section. In the fall, preregistration is on Tuesday, September 2
4 p.m. in 432 DL; in the spring, preregistration is on Monday, January
to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal
online placement exam at www.math.yale.edu/public_html/placement.
preregistering. Those who do not preregister may be excluded from se

MATH 120b, Calculus of Functions of Several Variables.

MWF 9.25-10.15

'08- '09

MWF 10.30-11.20

MWF 10.30-11.20

MWF 11.35-12.25

TTh 9.00-10.15

TTh 9.00-10.15

TTh 11.35-12.50

TTh 11.35-12.50

HTBA

QR (69)
Permission of instructor required

Analytic geometry in three dimensions, using vectors. Real-valued func
variables, partial derivatives, gradient and directional derivatives, level
maxima and minima. Parametrized curves in space, motion in space, li
Multiple integrals, with applications. Divergence and curl. The theorem
Gauss.
After MATH 115a *or* b, *or with permission of instructor.*

Introductory courses do not count toward the requirements of a major
wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec
specific section. In the fall, preregistration is on Tuesday, September 2
4 p.m. in 432 DL; in the spring, preregistration is on Monday, January
to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal
online placement exam at www.math.yale.edu/public_html/placement.
preregistering. Those who do not preregister may be excluded from se

MATH 190a, Fractal Geometry.

TTh 9.00-10.15 LOM 201

QR (22)

A visual introduction to the geometry of fractals and the dynamics of c
students not majoring in science. Study of mathematical patterns repe
expressions of these patterns in nature, art, music, and literature.

Introductory courses do not count toward the requirements of a major
wishing to enroll in MATH 112a or b, 115a or b, or 120a or b are expec
specific section. In the fall, preregistration is on Tuesday, September 2
4 p.m. in 432 DL; in the spring, preregistration is on Monday, January
to 4 p.m., also in 432 DL. Students who have not taken calculus at Yal
online placement exam at www.math.yale.edu/public_html/placement.
preregistering. Those who do not preregister may be excluded from se

MATH 222a, Linear Algebra with Applications.

MWF 10.30-11.20 WLH 119; 1 HTBA LOM 206

QR (33)

Matrix representation of linear equations. Gauss elimination. Vector sp
independence, basis, and dimension. Orthogonality, projection, least s
orthogonalization and orthogonal bases. Extension to function spaces.
Eigenvalues and eigenvectors. Diagonalization. Difference equation an
equations. Symmetric and Hermitian matrices. Orthogonal and unitary

similarity transformations.
May not be taken after MATH 225a *or* b.

MATH 222b, Linear Algebra with Applications.

MWF 10.30-11.20 ; 1 HTBA

TTh 9.00-10.15

QR (33)

Matrix representation of linear equations. Gauss elimination. Vector sp.
independence, basis, and dimension. Orthogonality, projection, least s
orthogonalization and orthogonal bases. Extension to function spaces.
Eigenvalues and eigenvectors. Diagonalization. Difference equation an
equations. Symmetric and Hermitian matrices. Orthogonal and unitary
similarity transformations.
May not be taken after MATH 225a *or* b.

MATH 225a, Linear Algebra and Matrix Theory.

TTh 11.35-12.50 LOM 202; 2 HTBA

QR (24)

An introduction to the theory of vector spaces, matrix theory and linea
determinants, eigenvalues, and quadratic forms. Some relations to cal
included.
After or concurrently with MATH 120a *or* b. *May not be taken after* MA`

MATH 225b, Linear Algebra and Matrix Theory.

TTh 9.00-10.15 ; HTBA

QR (22)

An introduction to the theory of vector spaces, matrix theory and linea
determinants, eigenvalues, and quadratic forms. Some relations to cal
included.
After or concurrently with MATH 120a *or* b. *May not be taken after* MA`

MATH 228a, From Euclid to Einstein.

MWF 2.30-3.20 LOM 214

QR (37)

An introduction to the fundamental role of symmetry in geometry. Trar
and its relation to Euclidean geometry, to non-Euclidean geometries, a
relativity. Includes a geometric introduction to linear algebra.

MATH 230a, Vector Calculus and Linear Algebra.

MWF 9.25-10.15 PR77 A002

QR (32)
Permission of instructor required

'08 - '09

A careful study of the calculus of functions of several variables, combir

MATH 230b, Vector Calculus and Linear Algebra.

TTh 11.35-12.50 ; 1 HTBA

QR (24)
Permission of instructor required

A careful study of the calculus of functions of several variables, combir

MATH 235b, Introductory Data Analysis.

MW 2.30-3.45

QR (0)

Survey of statistical methods: plots, transformations, regression, analy
principal components, contingency tables, and time series analysis. Th
and Web data sources are used.

MATH 241a, Probability Theory.

MWF 9.25-10.15 WLH 208

QR (32)

Introduction to probability theory. Topics include probability spaces, ra
expectations and probabilities, conditional probability, independence, d
distributions, central limit theorem, Markov chains, and probabilistic m
After or concurrently with MATH 120a *or* b *or equivalent.*

MATH 242b, Theory of Statistics.

MWF 9.25-10.15

QR (32)

Study of the principles of statistical analysis. Topics include maximum
distributions, estimation, confidence intervals, tests of significance, rec
variance, and the method of least squares. Some statistical computing
After STAT 241a *and concurrently with or after* MATH 222a *or* b *or* 225

MATH 244a, Discrete Mathematics.

TTh 11.35-12.50 LOM 214

QR (0)

Basic concepts and results in discrete mathematics: graphs, trees, con
theorem, enumeration, binomial coefficients, Stirling numbers. Propert
Recommended preparation: MATH 115a *or* b *or equivalent.*

MATH 246a, Ordinary Differential Equations.

TTh 2.30-3.45 LOM 205

'08 - '09

QR (0)

First-order equations, second-order equations, linear systems with con
Numerical methods. Complex variables and their applications.
After MATH 120a *or* b; *after or concurrently with* MATH 222a *or* b, *or* 2

MATH 246b, Ordinary Differential Equations.

TTh 9.00-10.15

(27)

First-order equations, second-order equations, linear systems with con
Numerical methods. Complex variables and their applications.
After MATH 120a *or* b; *after or concurrently with* MATH 222a *or* b, *or* 2

MATH 247b, Partial Differential Equations.

TTh 2.30-3.45

QR (27)

Introduction to partial differential equations; wave equation; Laplace's
method of characteristics; calculus of variations; series and transform
methods.
Prerequisites: MATH 222a *or* b *or* 225a *or* b, MATH 246a *or* b, ENAS 1⁹

MATH 250a, Vector Analysis.

MWF 9.25-10.15 LOM 214

QR (32)

Calculus of functions of several variables, using vector and matrix metl
function theorems. Transformation of multiple integrals. Line and surfa
fields. Curl and divergence. Differential forms. Theorems of Green, Gaᵤ
After MATH 120a *or* b, *and* 222a *or* b *or* 225a *or* b *or equivalent.*

MATH 251b, Stochastic Processes.

MW 1.00-2.15

QR (0)

Introduction to the study of random processes, including Markov chain
martingales, random walks, Brownian motion, and diffusions. Techniqu
coupling and large deviations. Applications to image reconstruction, Ba
probabilistic analysis of algorithms, and genetics and evolution.
After STAT 241a *or equivalent.*

MATH 260b, Basic Analysis in Function Spaces.

TTh 1.00-2.15

QR (26)

The standard basic functional analytic tools needed by scientists and uₛ
MATH 260b *is a natural continuation of* PHYS 301a.

MATH 270a, **Set Theory**.

MWF 1.30-2.20 DL 431

QR (36)

Algebra of sets; finite, countable, and uncountable sets. Cardinal numk
arithmetic. Order types and ordinal numbers. The axiom of choice and
theorem.
After MATH 120a *or* b *or equivalent.*

MATH 300b, **Topics in Analysis**.

MWF 11.35-12.25

QR (34)

An introduction to analysis, with topics chosen from infinite series, the
and fixed-point theorems with applications.
Students who have taken MATH 230 *should take* MATH 301a *instead oi*
250a *or with permission of instructor.*

MATH 301a, **Introduction to Analysis**.

TTh 1.00-2.15 LOM 215

QR (26)
Permission of instructor required

Foundations of real analysis, including metric spaces and point set topc
function spaces.
After MATH 230 *or equivalent.*

MATH 305b, **Real Analysis**.

TTh 1.00-2.15

QR (26)

The Lebesgue integral, Fourier series, applications to differential equat
After MATH 301a *or with permission of instructor.*

MATH 310a, **Introduction to Complex Analysis**.

TTh 11.35-12.50 DL 431

QR (24)

An introduction to the theory and applications of functions of a comple:
of complex functions. Complex integration and Cauchy?s theorem. Ser
residues. Conformal mapping.
After MATH 230 *or* 250a *or equivalent.*

MATH 315b, **Intermediate Complex Analysis**.

TTh 2.30-3.45

QR (27)
Permission of instructor required
Meets during reading period

Continuation of MATH 310a. Topics may include argument principle, Rc theorem, Runge?s theorem, analytic continuation, Schwarz reflection p formula, infinite products, Weierstrass theorem. Functions of finite ord meromorphic functions. Mittag-Leffler?s theorem, subharmonic functio
After MATH 310a.

MATH 320a, Measure Theory and Integration.

TTh 1.00-2.15 DL 431

QR (26)
Permission of instructor required
Meets during reading period

Construction and limit theorems for measures and integrals on general measures; Lp spaces; integral representation of linear functionals.
After MATH 305b *or equivalent.*

MATH 325b, Introduction to Functional Analysis.

TTh 1.00-2.15

QR (26)
Permission of instructor required
Meets during reading period

Hilbert, normed, and Banach spaces; geometry of Hilbert space, Riesz-space; Hahn-Banach theorem; Riesz representation theorems; linear o theorem; uniform boundedness, open mapping, and closed graph theo
After MATH 320a.

MATH 330b, Advanced Probability.

TTh 2.30-3.45

QR (0)

Measure theoretic probability, conditioning, laws of large numbers, con characteristic functions, central limit theorems, martingales.
Some knowledge of real analysis assumed.

MATH 350a, Introduction to Abstract Algebra.

MWF 10.30-11.20 LOM 215

QR (33)

Group theory, structure of Abelian groups, and applications to number and linear groups including orthogonal and unitary groups; properties (spaces. Some examples of group representations. Modules over Euclid rational canonical forms of a linear transformation.
After MATH 222a *or* b *or equivalent.*

MATH 353a, Introduction to Representation Theory.

TTh 2.30-3.45 DL 431

QR (27)

An introduction to basic ideas and methods of representation theory of groups. Examples include permutation groups and general linear group symmetric functions, geometry, and physics.
After MATH 222a *or* b *or equivalent.*

MATH 370b, Fields and Galois Theory.

TTh 11.35-12.50

QR (24)

Rings, with emphasis on integral domains and polynomial rings. The th theory, including finite fields, solvability of equations by radicals, and t of algebra. Quadratic forms.
After MATH 350a.

MATH 380a, Modern Algebra I.

MW 2.30-3.45 DL 431

QR (37)
Meets during reading period

A survey of algebraic constructions and theories at a sophisticated leve categorical language, free groups and other free objects in categories, and modules, artinian rings, and introduction to homological algebra.
After MATH 350a *and* 370b.

MATH 381b, Modern Algebra II.

TTh 2.30-3.45

QR (27)
Meets during reading period

Topics in commutative algebra: general extension of fields; Noetherian rings. Introduction to valuation theory. Rudiments of algebraic geomet
After MATH 380a.

MATH 435b, Differential Geometry.

TTh 9.00-10.15

QR (22)

Applications of calculus to the study of the geometry of curves and sur intrinsic differential geometric properties of manifolds, and connections geometries and topology.
After MATH 230 *or* 250a *or equivalent.*

MATH 440a, Introduction to Algebraic Geometry.

TTh 11.35-12.50 LOM 215

QR (0)

An introduction to algebraic geometry through the study of algebraic cu
curves in the projective plane and their intersection theory; Bezout's th
bundles; the Riemann-Hurwitz formula; hyperelliptic curves; and the R
Prerequisites: MATH 310a, 350a, *and some background in differential 1*

MATH 470a, Individual Studies.

1 HTBA

(0)

Individual investigation of an area of mathematics outside of those cov
involving directed reading, discussion, and either papers or an examina
study approved by the student?s adviser and the director of undergrad
The course may normally be elected for only one term.

MATH 470b, Individual Studies.

1 HTBA

(0)

Individual investigation of an area of mathematics outside of those cov
involving directed reading, discussion, and either papers or an examina
study approved by the student?s adviser and the director of undergrad
The course may normally be elected for only one term.

MATH 480a, Senior Seminar: Mathematical Topics.

TTh 2.30-3.45 LOM 214

(0)
Permission of instructor required

A number of mathematical topics are chosen each term - e.g., differen
mathematical methods in physics - and explored in one section of the s
several talks on the chosen topic. One section each year is devoted to
Economics and Mathematics majors, and is co-taught by a member of
department.

MATH 480b, Senior Seminar: Mathematical Topics.

HTBA

HTBA

(50)
Permission of instructor required

A number of mathematical topics are chosen each term - e.g., differen
mathematical methods in physics - and explored in one section of the s
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108 - '09