# Electives Program

**The Overarching Academic Program Goal**

Graduates anticipate and respond effectively to the uncertainties of a changing technological, social, political, [physical], and economic world.

**Mathematics and Science Goal**

Graduates are scientifically literate and are capable of applying scientific, mathematical, and computational modes of thought to the solution of complex problems.

# Electives Program Philosophy

Elective mathematics education at USMA:

- Extends the acquisition of a body of knowledge in depth started in the core program.
- Advances thought processes that are fundamental to understanding mathematics, science, and engineering.
- Furthers the attitudes and habits of the mind concerning creativity, curiosity, independence, and analytic rigor.

# Electives Program Goals

- Model physical phenomena
- Understand and apply theorems and methods
- Learn to argue rigorously; become an independent questioner
- Achieve proficiency in breadth and depth courses
- Communicate orally and in writing
- Use technology
- Develop attitudes
  - Creative and curious
  - Experimental disposition
  - Commitment to lifetime learning

# Mathematical Sciences Major

Mathematical Sciences major is among the most exciting and useful disciplines in the undergraduate curriculum at West Point.

A mathematics experience that compares favorably with other programs of national prominence.

Many cadets choose to study mathematical sciences because of the excellent preparation our programs provide for the Army and other future endeavors.

Cadets who study Mathematical Sciences at USMA can expect to be exposed to a broad spectrum of contemporary mathematical topic areas, including the following:

- Vector Calculus
- Differential Equations
- Linear Algebra
- Scientific Computing and Numerical Analysis
- Real Analysis
- Modeling and Operations Research
- Probability and Statistics

# Required Courses

## Math Sciences Major

**Required Courses** (9)

*With Department Head permission, MA464 may be substituted for MA466.*

| Subject Area | Description |
|---|---|
| MA 363 | Vector Calculus and Ordinary Differential Equations |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 383 | Foundations of Mathematics |
| MA 386 | Introduction to Numerical Analysis |
| MA 387 | Mathematical Analysis I |
| MA 391 | Mathematical Modeling |
| **MA 466 (464)** | **Abstract Algebra (Applied Algebra with Cryptology)** |
| MA 491 | Research Seminar in Applied Mathematics Projects |

# Required Courses

## Math Sciences Honors Major

**Required Courses** (10)

*With Department Head permission, MA464 may be substituted for MA466.*

| Subject Area | Description |
|---|---|
| MA 363 | Vector Calculus and Ordinary Differential Equations |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 383 | Foundations of Mathematics |
| MA 386 | Introduction to Numerical Analysis |
| MA 387 | Mathematical Analysis I |
| MA 391 | Mathematical Modeling |
| MA 466 (464) | Abstract Algebra (Applied Algebra with Cryptology) |
| **MA 498** | **Senior Thesis I: Research and Proposal** |
| **MA 499** | **Senior Thesis II: Paper and Defense** |

# Required Courses

## Math Studies Major

**Required Courses** (6)

| Subject Area | Description |
|---|---|
| MA 363 | Vector Calculus and Ordinary Differential Equations |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 383 | Foundations of Mathematics |
| MA 386 | Introduction to Numerical Analysis |
| MA 391 | Mathematical Modeling |

# Operations Research Major

The Operations Research major is an interdisciplinary program offered jointly by the Departments of Mathematical Sciences and Systems Engineering.

The major features a blend of ideas from applied mathematics and systems engineering.

The program is directly relevant to the Army; officers can serve in “Functional Area 49”.

Cadets who study Operations Research at USMA can expect to be exposed to a broad spectrum of contemporary operations research topic areas, including the following:

- Linear Optimization
- Nonlinear Optimization
- Linear Algebra
- Applied Statistics
- Mathematical Statistics
- Engineering Economy
- Deterministic Models
- Probabilistic Models

# Required Courses

**OR Major**

**Required Courses** (13)

| **Subject Area** | **Description** |
|---|---|
| EM 381 | Engineering Economy |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 381 | Nonlinear Optimization |
| MA 476 | Mathematical Statistics |
| MA 481 | Linear Optimization |
| SE 301 | Foundations of Engineering and Systems Management |
| SE 385 | Decision Analysis |
| SE 387 | Deterministic Models |
| SE 388 | Stochastic Models |
| SE 402 | Systems Design I |
| SE 403 | Systems Design II |
| MA 491 | Research Seminar in Applied Mathematics Projects |

# Required Courses

**OR Honors Major**

**Required Courses** (14)

| **Subject Area** | **Description** |
|---|---|
| EM 381 | Engineering Economy |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 381 | Nonlinear Optimization |
| MA 476 | Mathematical Statistics |
| MA 481 | Linear Optimization |
| SE 301 | Foundations of Engineering and Systems Management |
| SE 385 | Decision Analysis |
| SE 387 | Deterministic Models |
| SE 388 | Stochastic Models |
| SE 402 | Systems Design I |
| SE 403 | Systems Design II |
| **MA 498** | **Senior Thesis I: Research and Proposal** |
| **MA 499** | **Senior Thesis II: Paper and Defense** |

# Required Courses

## OR Studies Major

**Required Courses** (11)

| Subject Area | Description |
|---|---|
| EM 381 | Engineering Economy |
| MA 371 | Linear Algebra |
| MA 376 | Applied Statistics |
| MA 381 | Nonlinear Optimization |
| MA 481 | Linear Optimization |
| MA 491 | Research Seminar in Applied Mathematics Projects |
| SE 301 | Foundations of Engineering and Systems Management |
| SE 385 | Decision Analysis |
| SE 387 | Deterministic Models |
| SE 388 | Stochastic Models |
| SM 401 | Systems Management Capstone |

# Applied Statistics Minor

Applied statistical methods are primarily used to address problems outside of mathematics – thus, the minor is, by the very nature of the topic, interdisciplinary.

Data analysis is a valuable tool for future Army officers.

Increased statistical ability enhances the overall academic program in many majors.

The Center for Data Analysis and Statistics (CDAS) in the Math Department (formed in 2004) provides a natural support for the minor.

2 Required courses

MA476 Mathematical Statistics

MA376 (Applied Statistics) or SE375 (Statistics for Engineers)

3 Elective Courses from multiple departments

Social Sciences, BS&L, Physics, DPE, Math, SE

Includes possibly 1 applied statistics projects course from any department (with approval)

Must have 5 courses beyond major

# Required and Elective Courses

**Applied Statistics Minor**

| | |
|---|---|
| Required Course | Choose 1 of 1 |
| MA 476 | Mathematical Statistics |
| | |
| Required Course | Choose 1 of 2 |
| MA 376 | Applied Statistics |
| SE 375 | Statistics For Engineers |
| | |
| Electives | Choose 3 of 12 |
| KN 494 | Research Methods/Data Analysis |
| MA 371 | Linear Algebra |
| MA 488 | Special Topics In Mathematics |
| PH 361 | Experimental Physics |
| PH 481 | Statistical Physics |
| PL 386 | Experimental Psychology |
| PL 492 | Seminar In Behavioral Science – Network Science |
| PL 497 | Seminar In Behavioral Science |
| SE 388 | Stochastic Models |
| SE 481 | Systems Simulation |
| SS 368 | Econometrics I |
| SS 469 | Econometrics II |

# Interdisciplinary Courses

Cadets at USMA study mathematics as an integral part of other Math-Science-Engineering (MSE) disciplines.

Several of our mathematics electives offerings are primarily service courses, designed and maintained with our MSE partner disciplines in mind.

**MA364 Engineering Mathematics**

| | | |
|---|---|---|
| CHEM | CEN0 | Chemical Engineering |
| CHEM | CES0 | Chemical Engineering Studies |
| CME | CNG0 | Civil Engineering Studies |
| CME | CVN0 | Civil Engineering |
| CME | MEN0 | Mechanical Engineering |
| CME | MES0 | Mechanical Engineering Studies |
| EECS | EEN0 | Electrical Engineering |
| PHYS | NEN0 | Nuclear Engineering |
| PHYS | NES0 | Nuclear Engineering Science |

# Interdisciplinary

**MA366 Vector Calculus and Introduction to PDEs**

| | | |
|---|---|---|
| GEnE | EVE0 | Environmental Engineering |

**MA372 Introduction to Discrete Mathematics**

| | | |
|---|---|---|
| EECS | CSC0 | Computer Science |

**MA376 Applied Statistics**

| | | |
|---|---|---|
| BSL | AIH | Information Systems Engineering Major |
| BSL | EPS0 | Engineering Psychology Major |
| BSL | IHF0 | Info Sys Engr Major: Human Factors |
| EECS | ICS0 | Info Sys Engr: Computing Sys |