COMBINATORICS AND OPTIMIZATION

This degree concentration differs from the BA in Mathematics without a concentration only in the Concentration Requirements.

Bachelor of Arts - Mathematics; Combinatorics & Optimization Concentration

College Humanities & Sciences

Degree Specific Credits: 67

Required Cumulative GPA: 2.0

Catalog Year: 2017-2018

Note: The degree specific credits are much lower for double-majors and for students completing an additional minor (in another subject): 41 credits for students completing a second major, and 46 credits for students completing a minor.

General Education Requirements

Information regarding these requirements can be found in the General Education Section of the catalog.

Summary

Mathematics Core Courses 23

Upper-Division Mathematics Requirement 23

Upper-Division Elective Courses

Upper-Division Elective Computer Labs 3

Science Requirement 18

Advanced College Writing Requirement (usually fulfilled with a course that counts towards the Upper-Division Mathematics Requirement)

Foreign Language/Computer Science Requirement 3

Requirements for the Combinatorics & Optimization Concentration (usually fulfilled with courses that count towards the Upper-Division Mathematics Requirement)

Combinatorics & Optimization Concentration: Core Courses 3

Combinatorics & Optimization Concentration: Elective Courses 3

Total Hours 67

Mathematics Core Courses

Rule: Take all of the following courses.

M 171 Calculus I 4
or M 181 Honors Calculus I
M 172 Calculus II 4
or M 182 Honors Calculus II
M 210 Introduction to Mathematical Software 3
M 221 Introduction to Linear Algebra 4

M 273  Multivariable Calculus 4
M 300 Undergraduate Mathematics Seminar 1
M 307 Introduction to Abstract Mathematics 3

Total Hours 23

Minimum Required Grade: C-

Upper-Division Mathematics Requirement

Rule: Take 23 credits in this category.

Note:

1. Students completing a minor (in another subject) need take only 20 credits.
2. Students completing a second major need take only 18 credits.

Minimum Required Grade: C-

Upper-Division Elective Courses

Note:

1. Students completing a minor (in another subject) or a second major need take only 6 courses (totaling 18 credits or more).
2. Residency Requirement: At least 4 of the courses in this category must be taken at UM-Missoula (only 3 if M 307 is taken at UM-Missoula).
3. Note that STAT 451 does not count toward this requirement.

Take 7 courses from the following list; at least 3 of them must be at the 400 level:

M 301 Mathematics Technology for Teachers
M 311 Ordinary Differential Equations and Systems
M 325 Discrete Mathematics
M 326 Number Theory
M 361 Discrete Optimization
M 362 Linear Optimization
M 381 Advanced Calculus I
M 412 Partial Differential Equations
M 414 Deterministic Models
M 429 History of Mathematics
M 431 Abstract Algebra I
M 432 Abstract Algebra II
M 439 Euclidean and Non-Euclidean Geometry
M 440 Numerical Analysis
M 445 Statistical, Dynamical, and Computational Modeling
M 461 Practical Big Data Analytics
M 462 Theoretical Basics of Big Data Analytics and Real Time Computation Algorithms
M 472 Introduction to Complex Analysis
M 473 Introduction to Real Analysis
M 485 Graph Theory
STAT 341 Introduction to Probability and Statistics
STAT 421 Probability Theory
### Combinatorics and Optimization

#### STAT 422 Mathematical Statistics
#### STAT 452 Statistical Methods II

**Minimum Required Grade: C-**

### Upper-Division Elective Computer Labs

**Rule:** Computer labs from the following list are optional; if taken (0-2 credits), they count toward the total number of credits required for the Upper-Division Mathematics Requirement.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 317</td>
<td>Ordinary Differential Equations Computer Lab</td>
<td>1</td>
</tr>
<tr>
<td>M 363</td>
<td>Linear Optimization Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>M 418</td>
<td>Partial Differential Equations Computer Lab</td>
<td>1</td>
</tr>
<tr>
<td>STAT 457</td>
<td>Computer Data Analysis I</td>
<td>1</td>
</tr>
<tr>
<td>STAT 458</td>
<td>Computer Data Analysis II</td>
<td>1</td>
</tr>
</tbody>
</table>

**Minimum Required Grade: C-**

### Science Requirement

**Rule:** Take 18 credits in at most 3 areas selected from astronomy (ASTR), biology (BIO*), chemistry (CHMY), computer science (CSCI, except CSCI TR*), economics (ECNS), forestry (FORS, WILD), geosciences (GEO), management information systems (BMIS), and physics (PHSX).

**Note:**

1. Students completing a minor (in another subject) or a second major are exempt from this requirement.
2. Transfer courses listed on the transcript as "CSCI TR*" may include course work in other areas such as Computer Applications (CAPP) and therefore do not count towards this requirement unless a student successfully petitions the Department of Mathematical Sciences.

**Minimum Required Grade: C-**

**18 Total Credits Required**

### Advanced College Writing Requirement

**Rule:** Take 1 of the following 2 courses, or any other approved Advanced College Writing course.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 429</td>
<td>History of Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>M 499</td>
<td>Senior Thesis</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours**

**Minimum Required Grade: C-**

### Foreign Language/Computer Science Requirement

**Rule:** Either complete the General Education Requirement "Group III: Modern and Classical Language" (not the symbolic systems exception), or take one course from the following list.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 100</td>
<td>Intro to Programming</td>
<td>3</td>
</tr>
<tr>
<td>CSCI 135</td>
<td>Fund of Computer Science I</td>
<td>3</td>
</tr>
<tr>
<td>CSCI 136</td>
<td>Fund of Computer Science II</td>
<td>3</td>
</tr>
<tr>
<td>CSCI 250</td>
<td>Computer Modeling/Science Majors</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours**

**Minimum Required Grade: C-**

### Requirements for the Combinatorics & Optimization Concentration

**Minimum Required Grade: C-**

**12-13 Total Credits Required**

#### Combinatorics & Optimization Option: Core Courses

**Rule:** Take all of the following courses.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 361</td>
<td>Discrete Optimization</td>
<td>3</td>
</tr>
<tr>
<td>M 362</td>
<td>Linear Optimization</td>
<td>3</td>
</tr>
<tr>
<td>M 485</td>
<td>Graph Theory</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours**

**Minimum Required Grade: C-**

### Combinatorics & Optimization Concentration: Elective Courses

**Select one of the following:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 332</td>
<td>Design/Analysis of Algorithms</td>
<td>3-4</td>
</tr>
<tr>
<td>M 414</td>
<td>Deterministic Models</td>
<td>3-4</td>
</tr>
<tr>
<td>M 440</td>
<td>Numerical Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>STAT 341</td>
<td>Introduction to Probability and Statistics</td>
<td>3-4</td>
</tr>
</tbody>
</table>

**Total Hours**

**Minimum Required Grade: C-**

### GPA Requirement

**Note:**

1. A cumulative GPA of 2.0 is required for all courses used to fulfill major requirements.
2. In addition, a cumulative GPA of 2.0 is required for all mathematical sciences courses used to fulfill major requirements. (Mathematical sciences courses are those with a prefix of M or STAT.)