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: 2018-2019

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 (http://catalog.umt.edu/academics/general-education-requirements) of the catalog.

Summary

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mathematics Core Courses</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Upper-Division Mathematics Requirement</td>
<td>23</td>
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<tr>
<td></td>
<td>Science Requirement</td>
<td>18</td>
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<td>Advanced College Writing Requirement</td>
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<td>Foreign Language/Computer Science Requirement</td>
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<td>Requirements for the Combinatorics &amp; Optimization Concentration</td>
<td>3</td>
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<tr>
<td></td>
<td>Combinatorics &amp; Optimization Concentration: Core Courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combinatorics &amp; Optimization Concentration: Elective Courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Hours</td>
<td>67</td>
</tr>
</tbody>
</table>

Mathematics Core Courses

Rule: Take all of the following courses.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 171</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>or M 181</td>
<td>Honors Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>M 172</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>or M 182</td>
<td>Honors Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>M 210</td>
<td>Introduction to Mathematical Software</td>
<td>3</td>
</tr>
<tr>
<td>M 221</td>
<td>Introduction to Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>M 273</td>
<td>Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>M 300</td>
<td>Undergraduate Mathematics Seminar</td>
<td>1</td>
</tr>
<tr>
<td>M 307</td>
<td>Introduction to Abstract Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>Total Hours</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 301</td>
<td>Mathematics Technology for Teachers</td>
</tr>
<tr>
<td>M 311</td>
<td>Ordinary Differential Equations and Systems</td>
</tr>
<tr>
<td>M 325</td>
<td>Discrete Mathematics</td>
</tr>
<tr>
<td>M 326</td>
<td>Number Theory</td>
</tr>
<tr>
<td>M 361</td>
<td>Discrete Optimization</td>
</tr>
<tr>
<td>M 362</td>
<td>Linear Optimization</td>
</tr>
<tr>
<td>M 381</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>M 412</td>
<td>Partial Differential Equations</td>
</tr>
<tr>
<td>M 414</td>
<td>Deterministic Models</td>
</tr>
<tr>
<td>M 429</td>
<td>History of Mathematics</td>
</tr>
<tr>
<td>M 431</td>
<td>Abstract Algebra I</td>
</tr>
<tr>
<td>M 432</td>
<td>Abstract Algebra II</td>
</tr>
<tr>
<td>M 439</td>
<td>Euclidean and Non-Euclidean Geometry</td>
</tr>
<tr>
<td>M 440</td>
<td>Numerical Analysis</td>
</tr>
<tr>
<td>M 445</td>
<td>Statistical, Dynamical, and Computational Modeling</td>
</tr>
<tr>
<td>M 461</td>
<td>Data Science Analytics</td>
</tr>
<tr>
<td>M 462</td>
<td>Theoretical Basics of Big Data Analytics and Real Time Computation Algorithms</td>
</tr>
<tr>
<td>M 472</td>
<td>Introduction to Complex Analysis</td>
</tr>
</tbody>
</table>
### Combinatorics and Optimization

**M 473** Introduction to Real Analysis  
**M 485** Graph Theory  
**STAT 341** Introduction to Probability and Statistics  
**STAT 421** Probability Theory  
**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>Code</th>
<th>Title</th>
<th>Hours</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>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 429</td>
<td>History of Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>or M 499</td>
<td>Senior Thesis</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 3  
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.

**Note:** Students completing a second major are exempt from this requirement.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 100</td>
<td>Intro to Programming</td>
<td>3</td>
</tr>
<tr>
<td>CSCI 126</td>
<td>Computation in the Sciences with Calculus</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>
</tbody>
</table>

Total Hours 3  
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>Code</th>
<th>Title</th>
<th>Hours</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 9  
Minimum Required Grade: C-

### Combinatorics & Optimization Concentration: Elective Courses

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</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</td>
</tr>
<tr>
<td>M 440</td>
<td>Numerical Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT 341</td>
<td>Introduction to Probability and Statistics</td>
<td>3-4</td>
</tr>
</tbody>
</table>

Total Hours 3-4  
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.)