## Interdisciplinary

### Degrees Offered
- Master of Science (Interdisciplinary)
- Doctor of Philosophy (Interdisciplinary)

### Program Description
In addition to its traditional degree programs, Mines offers innovative, interdisciplinary, research-based degree programs that fit the institutional role and mission, but cannot easily be addressed within a single discipline or degree program. Specialties offered under this option are provided for a limited time during which faculty from across campus come together to address relevant, timely, interdisciplinary issues. The Interdisciplinary Graduate Program is intended to:

1. Encourage faculty and students to participate in broadly interdisciplinary research,
2. Provide a mechanism by which a rigorous academic degree program may be tightly coupled to this interdisciplinary research, and
3. Provide a mechanism for faculty to develop and market test, timely and innovative interdisciplinary degree programs in the hope that, if successful, may become full-fledged, stand-alone degree programs in the future.

### Program Requirements
Graduates of the Interdisciplinary Graduate Program must meet all institutional requirements for graduation and the requirements of the Specialty under which they are admitted.

### Program Management
Overall management and oversight of the Interdisciplinary Degree Program is undertaken by a Program Oversight Committee consisting of:

- Dean of Graduate Studies (Chair and Program Director),
- One Representative from the Faculty Senate,
- One Representative from Department Heads/Division Directors, and
- One Faculty Representative from each active Specialty Areas.

The role of the Oversight Committee is fourfold:

- **Specialty Oversight:** includes advising and assisting faculty in the creation of new Specialty areas, periodic Specialty review and termination of Specialties having exceed the allowed time limits,
- **Specialty Mentoring:** includes providing assistance to, and support of existing Specialties as they move toward applying for full degree status,
- **Program Advocacy:** includes promotion of program at the institutional level, and promotion, development and support of new Specialty areas with individual groups of faculty, and
- **Council Representation:** upon the advise of the directors of the individual Specialties offered, the Oversight Committee appoints an Interdisciplinary Degree program representative to Graduate Council.

### Specialty Requirements and Approval Processes
Specialties must meet the following minimum requirements:

- Specialty area must be, within the context of Mines, interdisciplinary in nature. That is, expertise that would be reasonably expected to be required to deliver the specialty must span multiple degree programs at Mines.
- Faculty participating in the Specialty must be derived from no fewer than two separate home units.
- There must be a minimum of six tenure/tenure-track core faculty participating in the Specialty.

The package of materials to be reviewed for Specialty approval must, at a minimum, include the following items:

- Descriptive overview of Specialty degree area,
- List of participating Faculty and the Departments/Divisions in which they are resident,
- Name of Specialty to be included on the transcript,
- Listing and summary description of all Specialty degree requirements,
- A description of how program quality is overseen by participating Specialty faculty including the Admission to Candidacy process to be used within the Specialty,
- A copy of Bylaws (i.e., operating parameters that define how the Specialty is managed, how faculty participate, how admissions is handled, etc.) under which the Specialty and its faculty operate,
- A listing and justification for any additional resources needed to offer the Specialty, and
- A draft of the Graduate Bulletin text that will be used to describe the Specialty in the Interdisciplinary Degree section of Bulletin.

Materials for Specialty approval must be approved by all of the following groups. Faculty advancing a Specialty should seek approval from each group in the order in which they are presented below:

- Faculty and Department Heads/Division Directors of each of the departments/divisions contributing staffing to the Specialty,
- Interdisciplinary Program Oversight Committee,
- Graduate Council,
- Faculty Senate, and
- Provost.

Failure to receive approval at any level constitutes an institutional decision to not offer the Specialty as described.

### Full-Fledged Degree Creation and Specialty Time Limits
Documentation related to specific program Specialties, as published in the Graduate Bulletin, includes the inception semester of the Specialty. For Specialties garnering significant enrollment and support by participating academic faculty, the Program Oversight Committee encourages the participating faculty to seek approval – both on campus, and through the Board of Trustees and DHE – for a stand alone degree program. Upon approval, all students still in the Specialty will be moved to the full-fledged degree program.

Admissions to all doctoral-level Specialties will be allowed for a maximum of 7 years after the Specialty inception date. Specialties may apply to the
Oversight Committee for a one-time extension to this time limit that shall not exceed 3 additional years. If successful, the Oversight Committee shall inform Graduate Council and the Faculty Senate of the extension.

**Specialties**

Operations Research with Engineering (ORwE) (initiated Fall, 2011)

**Degrees Offered**

- Doctor of Philosophy (Interdisciplinary); Specialty (Operations Research with Engineering)

**Program Description**

Operations Research (OR) involves mathematically modeling physical systems (both naturally occurring and man-made) with a view to determining a course of action for the system to either improve or optimize its functionality. Examples of such systems include, but are not limited to, manufacturing systems, chemical processes, socio-economic systems, mechanical systems (e.g., those that produce energy), and mining systems. The ORwE PhD Specialty allows students to complete an interdisciplinary doctoral degree in Operations Research with Engineering by taking courses and conducting research in eight departments/divisions: Applied Mathematics and Statistics, Electrical Engineering and Computer Sciences, Engineering and Computational Sciences, Civil and Environmental Engineering, Economics & Business, Mining Engineering, Mechanical Engineering, and Metallurgical & Materials Engineering.

**Specialty Requirements**

Doctoral students develop a customized curriculum to fit their needs. The degree requires a minimum of 72 graduate credit hours that includes course work and a thesis. Coursework is valid for nine years towards a Ph.D. degree; any exceptions must be approved by the Director of the ORwE program and student advisor.

**Course Work**

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>25.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Specialization Courses</td>
<td>12.0</td>
</tr>
<tr>
<td>Total Semester Hrs</td>
<td>37.0</td>
</tr>
</tbody>
</table>

**Research Credits**

At least 24.0 research credits. The student’s faculty advisor and the doctoral thesis committee must approve the student’s program of study and the topic for the thesis.

**Qualifying Examination Process and Thesis Proposal**

Upon completion of the core coursework, students must pass qualifying written examinations to become a candidate for the Ph.D. ORwE specialty. The proposal defense should be done within ten months of passing the qualifying exam.

**Transfer Credits**

Students may transfer up to 24.0 hours of graduate-level coursework from other institutions toward the Ph.D. degree subject to the restriction that those courses must not have been used as credit toward a Bachelor’s degree. The student must have achieved a grade of B or better in all graduate transfer courses and the transfer must be approved by the student’s Doctoral Thesis Committee and the Director of the ORwE program.

**Unsatisfactory Progress**

In addition to the institutional guidelines for unsatisfactory progress as described elsewhere in this bulletin: Unsatisfactory progress will be assigned to any full-time student who does not pass the following prerequisite and core courses in the first fall semester of study:

- CSCI262: DATA STRUCTURES 3.0
- EBGN555: LINEAR PROGRAMMING 3.0
- MATH530: STATISTICAL METHODS I 3.0

and the following in the first spring semester of study:

- CSCI406: ALGORITHMS 3.0
- MEGN593: ENGINEERING DESIGN OPTIMIZATION 3.0

Unsatisfactory progress will also be assigned to any students who do not complete requirements as specified in their admission letter. Any exceptions to the stipulations for unsatisfactory progress must be approved by the ORwE committee. Part-time students develop an approved course plan with their advisor.

**Prerequisites**

Students must have completed the following undergraduate prerequisite courses with a grade of B or better:

- CSCI261: PROGRAMMING CONCEPTS 3.0
- CSCI262: DATA STRUCTURES 3.0

Students entering in the fall semester must have completed the Programming (CSCI261) prerequisite or equivalent. Students will only be allowed to enter in the spring semester if they have developed a course program such that they are able to take the qualifying exam within 3 semesters.

**Required Course Curriculum**

All Ph.D. students are required to take a set of core courses that provides basic tools for the more advanced and specialized courses in the program.

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>3.0</th>
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<tbody>
<tr>
<td>CSCI/MATH406: ALGORITHMS</td>
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<tr>
<td>EBGN555: LINEAR PROGRAMMING</td>
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<tr>
<td>MEGN502: ADVANCED ENGINEERING ANALYSIS</td>
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<tr>
<td>MATH530: STATISTICAL METHODS I</td>
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<tr>
<td>MATH438: STOCHASTIC MODELS</td>
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<tr>
<td>MEGN593: ENGINEERING DESIGN OPTIMIZATION</td>
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<tr>
<td>Total Semester Hrs</td>
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</table>

**Area of Specialization Courses**

Select Four of the Following: 12.0

- EBGN528: INDUSTRIAL SYSTEMS SIMULATION
- MATH542SIMULATION
- CSCI542: SIMULATION
<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>MTGN450/</td>
<td>STATISTICAL PROCESS CONTROL AND DESIGN OF EXPERIMENTS</td>
</tr>
<tr>
<td>MLGN550</td>
<td>DECISION ANALYSIS</td>
</tr>
<tr>
<td>EEBN560</td>
<td>THEORY AND DESIGN OF ADVANCED CONTROL SYSTEMS</td>
</tr>
<tr>
<td>EEBN655</td>
<td>ADVANCED LINEAR PROGRAMMING</td>
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<tr>
<td>CSCN562</td>
<td>APPLIED ALGORITHMS AND DATA STRUCTURES</td>
</tr>
<tr>
<td>MNGN536</td>
<td>OPERATIONS RESEARCH TECHNIQUES IN THE MINERAL INDUSTRY</td>
</tr>
<tr>
<td>MNGN538</td>
<td>GEOSTATISTICAL ORE RESERVE ESTIMATION</td>
</tr>
<tr>
<td>EEBN509</td>
<td>MATHEMATICAL ECONOMICS</td>
</tr>
<tr>
<td>EEBN575</td>
<td>ADVANCED MINING AND ENERGY ASSET VALUATION</td>
</tr>
<tr>
<td>MATH531</td>
<td>STATISTICAL METHODS II</td>
</tr>
<tr>
<td>xxx598/698</td>
<td>Special Topics (Requires approval of the advisor</td>
</tr>
<tr>
<td></td>
<td>and ORwE program director)</td>
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</tbody>
</table>