This handbook provides a detailed description of the Master of Science in Industrial Mathematics (aka the Professional Science Master’s (PSM) in Industrial Mathematics) program with specific information for this program. More general information related to academic program and graduates degrees can be found in the Graduate Student Handbook (available online) by the Graduate Office in the Department of Mathematics, and other University documents and online resources. If you have any questions about the requirements, or have a question not answered here, feel free to come to the Office of Graduate Studies, C213 Wells Hall, for help.

For particular information about the program, contact Dr. Peiru Wu, Director of PSM in Industrial Mathematics at peiruwu@msu.edu or msim@math.msu.edu.
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I Program Overview

Overview

The goal of Master of Science in Industrial Mathematics (MSIM) program is to produce generalized problem solvers of great versatility, capable of moving within an organization from task to task. The program has been successfully training data analysts/data scientists, mathematician, and problem solvers for leadership positions in industry for two decades because

- The graduates will have studied standard mathematical and statistical tools, and computer science principles to strengthen data analytics skills and machine learning skills.
- They will have gained experience in hands-on project development for real-world problems proposed by local companies and they will received training in technical writing for the project reports to meet industrial standard.

The degree requires 30 credits of coursework, the successful completion of the Certificate Program in Project Management, and the successful completion of an oral masters certifying examination on the student’s portfolio of completed projects.

Program Components (See Section III Program Curriculum for a detailed description)

- Industrial Mathematical Core Courses (6 credits, MTH 843 (Fall), MTH 844 (Spring))
- Elective and Cognate Courses (24 credits, MTH, STT, CSE/CMSE etc.)
- Certificate in Project Management (PHM 857, as for a “not-for-credit” option, first Summer)
- Portfolio Defense (last semester)

Professional Science Master’s (PSM) Program: The MSIM program has blossomed since its inception since late 90s (PSM affiliation in 1998). With initial support from the Alfred P. Sloan Foundation, our program, called the PSM in Industrial Mathematics continues to get national recognition as one of the earliest and the best-established Professional Science Master’s (PSM).

Recall, the PSM program nationwide is an innovative, new graduate degree designed to combine advanced training in science or mathematics, while simultaneously developing workplace skills highly valued by employers. “Professional Science Master's (PSMs) are designed for students who are seeking a graduate degree in science or mathematics and understand the need for developing workplace skills valued by top employers. A perfect fit for professionals because it allows you to pursue advanced training and excel in science or math without a Ph.D., while simultaneously developing highly-valued business skills.” (See the national PSM website at https://www.professionalsciencemasters.org for more descriptions). The PSM programs in US have two decades of history with continued success because of High Demand and Science-Plus Curricula (Go to the national PSM website for more details).

One of major successes of the PSM in Industrial Mathematics program at MSU is our twenty years of industrial partnership and strong connections with local companies. We also have the industrial advisory board from 30 companies since 1999 and those industrial advisors include executive, president, vice president, director, technical fellow, and chief analytic officer from
world well-known companies. Another success is that our graduates are employed in 25 states with \(~100\%\) of placement rate that were actively seeking employment.

II Admission Requirements

Admission

Students who wish to apply for an admission to the Master of Science in Industrial Mathematics (MSIM) program should

- Have completed the mathematics or applied mathematics course normally required for the bachelor’s degree with a major in mathematics, statistics, economics, physics, or any science or engineering.
- Have coursework at the senior level in mathematical analysis, linear algebra, and differential equations.
- Have some familiarity with mathematical software programs such as Mathematica, MATLAB, as well as some knowledge of programing languages.

Application will be reviewed based on academic record that shows background for success in the program, and professional goal that would be furthered by the coursework and training in the program, as well as letters of recommendation that indicate the likelihood of success for meeting the program requirements and completing the MSIM degree.

We are accepting late applications and please contact us at msim@math.msu.edu for discussion.

How to Apply

A complete application for the MSIM program includes the following:

1. MSU Graduate Application at https://admissions.msu.edu/apply/graduate-students to indicate your intended major as Industrial Mathematics.

2. The Mathematics Department requires a current CV/resume, Academic Statement and Personal Statement be included or uploaded within this MSU Graduate Application.

3. Three letters of recommendation are required, and these are included in the application also.

4. Within the application you will select Industrial Mathematics as your intended major and you will be asked for the supplemental questions. Within these questions should contain the Math and Statistics Classes you have (or will have) taken at the Junior, Senior, or Graduate level.

5. Official transcripts of all college work (undergraduate and graduate), including diplomas and certificate are also required. These are to be sent to our department directly from the school(s) which you attended.

Our mailing address is as follows:
There is no need to send more than one set of transcripts. We will forward the original transcript to the Office of Admissions.

6. GRE Scores - The three standard sections of the GRE, verbal, quantitative, and analytic are required for admission.

7. TOEFL Scores (International Students Only) - Applicants for whom English is not their primary language are required to submit TOEFL (Test of English as a Foreign Language) or IELTS (International English Language Testing System) scores. TOEFL scores must meet the University minimum requirements: no subscore below 19 for reading, listening, and speaking; no writing subscore below 22; with a minimum total score of 80. For more details see: https://grad.msu.edu/english-language-competency

8. The financial proof (Affidavit of Support for Graduate International Students at https://grad.msu.edu/sites/default/files/content/apply/AffidavitofSupport_form.pdf) for International Students. See more information regarding the Financial Proof (e.g., Estimated funding requirements for international students) at https://grad.msu.edu/internationalapplicants

Applications are accepted for Fall Semester only. We do not accept applications for Spring or Summer Semester.

III Program Curriculum

In addition to meeting the requirements of the University and the College of Natural Science, the MSIM student must complete a total of 30 credits of graduate coursework including (1) core courses, (2) elective and cognate courses, (3) the successful completion of the Certificate Program in Project Management, and (4) the successful completion of an oral masters certifying examination on the student’s portfolio of completed projects.

Core Courses (6 credits)
MTH 843 Survey of Industrial Mathematics (fall semester)
MTH 844 Projects in Industrial Mathematics (spring semester)

Elective and Cognate Courses (24 credits)
A minimum of two of the following courses:
MTH 810 Error-Correcting Codes
MTH 841 Boundary Value Problems I
MTH 842 Boundary Value Problems II
MTH 847 Partial Differential Equations I
MTH 849 Partial Differential Equations II
MTH 850  Numerical Analysis I
MTH 852  Numerical Methods for ODE
MTH 880  Combinatorics
MTH 881  Graph Theory

A minimum of two of the following courses:

STT 801  Design of Experiments
STT 802  Statistical Computation
STT 843  Multivariate Analysis
STT 844  Time Series Analysis
STT 847  Analysis of Survival Data
STT 861  Theory of Probability and Statistics I
STT 862  Theory of Probability and Statistics II
STT 863  Applied Statistics Methods I
STT 864  Applied Statistics Methods II
STT 866  Spatial Data Analysis
STT 875  R Programming for Data Sciences
STT 886  Stochastic Processes and Applications
STT 888  Stochastic Models in Finance

A minimum of two of the following courses:

CMSE 801  Introduction to Computational Modeling
CMSE 802  Methods in Computational Modeling
CMSE 820  Mathematical Foundations of Data Science
CMSE 821  Numerical Methods for Differential Equations
CMSE 822  Parallel Computing
CMSE 823  Numerical Linear Algebra
CSE 802  Pattern Recognition and Analysis
CSE 803  Computer Vision
CSE 830  Design and Theory of Algorithms
CSE 835  Algorithmic Graph Theory
CSE 836  Probabilistic Models and Algorithms in Computational Biology
CSE 841  Artificial Intelligence
CSE 847  Machine Learning
CSE 860  Foundations of Computing
CSE 872  Advanced Computer Graphics
CSE 880  Advanced Database Systems
CSE 881  Data Mining
CSE 885  Artificial Neural Networks
EC 811A  Mathematical Applications in Economics
EC 811B  The Structure of Economic Analysis
EC 812A  Microeconomics I
EC 812B  Microeconomics II
EC 813A  Macroeconomics I
EC 813B  Macroeconomics II and its Mathematical Foundations
EC 820A  Econometrics IA
EC 820B  Econometrics IB
EC 821A Cross Section and Panel Data Econometrics I
EC 821B Cross Section and Panel Data Econometrics II
EC 822A Time Series Econometrics I
EC 822B Time Series Econometrics II
ECE 848 Evolutionary Computation
ECE 849 Digital Image Processing
ECE 863 Analysis of Stochastic Systems
ME 830 Fluid Mechanics I
ME 840 Computational Fluid Dynamics and Heat Transfer
ME 872 Finite Element Method
MKT 805 Marketing Management
MKT 806 Marketing Research for Decision Making
MKT 816 Marketing Analysis
MKT 819 Advanced Marketing Research
MKT 864 Data Mining in Marketing
SCM 800 Supply Chain Management
SCM 815 Emerging Topics in Supply Management
SCM 826 Manufacturing Design and Analysis
SCM 833 Decision Support Models
SCM 843 Sustainable Supply Chain Management
SCM 853 Operations Strategy
SCM 854 Integrated Logistics Systems

The students can learn more about the course descriptions on The Office of the Registrar website at [https://reg.msu.edu/Courses/Search.aspx](https://reg.msu.edu/Courses/Search.aspx).

The students will discuss with the academic advisor (program director) about your course planning prior to fall semester. See Section IV Other Information for course planning examples.

**Certificate Program in Project Management** (only offer in summer)
It requires completion of PHM 857 Project Management, covering such topics as formal project management culture, principles, knowledge areas, and terminology. It will normally be undertaken during the first year of enrollment as a “not-for-credit” option. Certification will also require participation in Industrial Mathematics-specific discussion sessions. After completion of the certificate program is approved by the instructors, the Industrial Mathematics Program, and the Associate Dean of the College of Natural Science, the Office of the Registrar will enter the certificate on the student’s academic record along with the term in which it was completed.

**Portfolio Defense**
It requires defending a portfolio of major work to fulfill the requirements of the MSIM program in the last semester. This includes at least three project reports written as part of MTH 843 and the industrial project report(s) done as your participation in MTH 844 project team(s) plus possible projects done under other course during your study in the program. The defense is about 1.5 hours oral examination conducted by three MSU faculty members. The students are expected to be thoroughly conversant with their entire portfolio and so are expected to do the following from memory with little, if any, reference to the individual reports.
IV Other Information

Examples of Course Planning

The following course planning are completed by MSIM graduates in the past to meet the course requirements for a total of 36 credits (i.e., Core (2), MTH (4), STT (2), Cognate (4), 12 courses in general) in addition to successful completion of the Certificate Program (PHM 857) and the portfolio defense.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Student A Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Student B Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>MTH 843</td>
<td>Survey of Industrial Mathematics</td>
<td>Core</td>
<td>MTH 843</td>
<td>Survey of Industrial Mathematics</td>
<td>Core</td>
</tr>
<tr>
<td></td>
<td>MTH 841</td>
<td>Boundary Value Problems I</td>
<td>MTH</td>
<td>MTH 850</td>
<td>Numerical Analysis I</td>
<td>MTH</td>
</tr>
<tr>
<td>Spring</td>
<td>MTH 844</td>
<td>Projects in Industrial Mathematics</td>
<td>Core</td>
<td>MTH 844</td>
<td>Projects in Industrial Mathematics</td>
<td>Core</td>
</tr>
<tr>
<td></td>
<td>MTH 842</td>
<td>Boundary Value Problems II</td>
<td>MTH</td>
<td>MTH 851</td>
<td>Numerical Analysis II</td>
<td>MTH</td>
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<tr>
<td></td>
<td>MKT 806</td>
<td>Marketing Research for Decision Making</td>
<td>Cognate</td>
<td>STT 843</td>
<td>Multivariate Analysis</td>
<td>STT</td>
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<td>Summer</td>
<td>PHM 857</td>
<td>Project Management</td>
<td>Certificate</td>
<td>PHM 857</td>
<td>Project Management</td>
<td>Certificate</td>
</tr>
<tr>
<td>Fall</td>
<td>MTH 850</td>
<td>Numerical Analysis I</td>
<td>MTH</td>
<td>MTH 841</td>
<td>Boundary Value Problems I</td>
<td>MTH</td>
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<tr>
<td></td>
<td>STT 863</td>
<td>Applied Statistics Methods I</td>
<td>STT</td>
<td>STT 801</td>
<td>Design of Experiments</td>
<td>STT</td>
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<td>CSE 881</td>
<td>Data Mining</td>
<td>Cognate</td>
<td>CSE 881</td>
<td>Data Mining</td>
<td>Cognate</td>
</tr>
<tr>
<td>Spring</td>
<td>MTH 851</td>
<td>Numerical Analysis II</td>
<td>MTH</td>
<td>MTH 810</td>
<td>Error-Correcting Codes</td>
<td>MTH</td>
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<tr>
<td></td>
<td>CSE 802</td>
<td>Pattern Recognition and Analysis</td>
<td>Cognate</td>
<td>CSE 830</td>
<td>Design and Theory of Algorithms</td>
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<td>CSE 830</td>
<td>Design and Theory of Algorithms</td>
<td>Cognate</td>
<td>MTH 890</td>
<td>Readings in Mathematics (Projects in Industrial Mathematics)</td>
<td>Cognate</td>
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<tr>
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<td>MTH 890</td>
<td>Readings in Mathematics (Projects in Industrial Mathematics)</td>
<td>Cognate</td>
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</table>

<table>
<thead>
<tr>
<th>Semester</th>
<th>Student C Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Student D Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>MTH 843</td>
<td>Survey of Industrial Mathematics</td>
<td>Core</td>
<td>MTH 843</td>
<td>Survey of Industrial Mathematics</td>
<td>Core</td>
</tr>
<tr>
<td></td>
<td>MTH 850</td>
<td>Numerical Analysis I</td>
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<td>MTH 850</td>
<td>Numerical Analysis I</td>
<td>MTH</td>
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<tr>
<td></td>
<td>MKT 805</td>
<td>Marketing Management</td>
<td>Cognate</td>
<td>EC 820A</td>
<td>Econometrics IA</td>
<td>Cognate</td>
</tr>
<tr>
<td>Spring</td>
<td>MTH 844</td>
<td>Projects in Industrial Mathematics</td>
<td>Core</td>
<td>MTH 844</td>
<td>Projects in Industrial Mathematics</td>
<td>Core</td>
</tr>
<tr>
<td></td>
<td>MTH 810</td>
<td>Error-Correcting Codes</td>
<td>MTH</td>
<td>STT 844</td>
<td>Time Series Analysis</td>
<td>STT</td>
</tr>
<tr>
<td></td>
<td>STT 844</td>
<td>Time Series Analysis</td>
<td>STT</td>
<td>EC 820B</td>
<td>Econometrics IB</td>
<td>Cognate</td>
</tr>
<tr>
<td>Summer</td>
<td>PHM 857</td>
<td>Project Management</td>
<td>Certificate</td>
<td>PHM 857</td>
<td>Project Management</td>
<td>Certificate</td>
</tr>
<tr>
<td>Fall</td>
<td>MTH 841</td>
<td>Boundary Value Problems I</td>
<td>MTH</td>
<td>MTH 841</td>
<td>Boundary Value Problems I</td>
<td>MTH</td>
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<tr>
<td></td>
<td>STT 861</td>
<td>Theory of Probability and Statistics I</td>
<td>STT</td>
<td>EC 821A</td>
<td>Cross Section and Panel Data Econometrics I</td>
<td>Cognate</td>
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<tr>
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<td>CSE 881</td>
<td>Data Mining</td>
<td>Cognate</td>
<td>CSE 881</td>
<td>Data Mining</td>
<td>Cognate</td>
</tr>
<tr>
<td>Spring</td>
<td>MTH 842</td>
<td>Boundary Value Problems II</td>
<td>MTH</td>
<td>MTH 842</td>
<td>Boundary Value Problems II</td>
<td>MTH</td>
</tr>
<tr>
<td></td>
<td>CSE 885</td>
<td>Artificial Neural Networks</td>
<td>Cognate</td>
<td>MTH 852</td>
<td>Numerical Methods for ODE</td>
<td>MTH</td>
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<tr>
<td></td>
<td>MTH 890</td>
<td>Readings in Mathematics (Projects in Industrial Mathematics)</td>
<td>Cognate</td>
<td>STT 864</td>
<td>Applied Statistical Methods II</td>
<td>STT</td>
</tr>
</tbody>
</table>
Form of Annual Progress Review for the PSM Students

**PERFORMANCE EXPECTATIONS FOR THE STUDENTS IN PSM IN INDUSTRIAL MATHEMATICS AT MICHIGAN STATE UNIVERSITY**

Student (Print) ___________________________  Semester ____________

Student (Signature*) ______________________  Date ________________

* Signature acknowledges review; it does not imply that student agrees with all comments.

Advisor (Signature) ___________________________  Date ________________

1. **PROFESSIONAL CRITERIA:**

   a) **Professional Deportment** – In advance of each semester, the student will provide to his/her advisor a formal memo outlining semester courses and goals. Each student is expected to prepare for and attend job fairs, and to inform the program coordinator via memo of the outcome of each fair. All academic and professional duties are to be completed within schedule.

   b) **Team Building** – Each student will promote teamwork while performing as an individual contributor during the course work and projects in MTH 843 and MTH 844. Each team member must be open and candid with their peers and faculty manager. Students are expected to study teaming theory and to continually practice and improve their teaming skills.

   c) **Communication Skills** – Each student will communicate clearly, concisely, and professionally. This requires timely oral and written communications with the program coordinator, peers and faculty manager regarding projects, summer internships (or co-ops), job searches, and professional improvement etc. Students are expected to continually improve their communication skills.

2. **PERFORMANCE EXPECTATIONS:**

<table>
<thead>
<tr>
<th>Top: Performance that substantially exceeds the expectations of the PSM student</th>
<th>Middle: Performance that fully meets the expectations of the PSM student</th>
<th>Low: Performance that does not meet the expectations of the PSM student</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Student excelled at obligations as a professional graduate and demonstrated initiative</td>
<td>▪ Followed directions and discharged obligations in this professional training program</td>
<td>▪ Reluctantly followed directions or resisted training in the program</td>
</tr>
<tr>
<td>▪ Recognized a need and took significant action in this professional training</td>
<td>▪ Understood role and cooperated with training positively</td>
<td>▪ Minimal understanding of training and minimal action beyond what was asked</td>
</tr>
<tr>
<td>▪ Exceeded major goals in a way that benefited personal growth and learning</td>
<td>▪ Successfully achieved professional and personal goals that meet the program requirements</td>
<td>▪ Barely meet the program requirement and minimal improvement related to development goals</td>
</tr>
<tr>
<td>▪ Consistently demonstrated PSM professionalism and discipline</td>
<td>▪ Regularly demonstrated PSM professionalism and discipline</td>
<td>▪ Poorly demonstrated PSM professionalism and discipline</td>
</tr>
</tbody>
</table>
3. PERFORMANCE REVIEW AND IMPROVEMENT AREAS BY THE STUDENT*:

* Read items 1 and 2 regarding the criteria and expectations for the students in Professional Science Master’s (PSM) Program in Industrial Mathematics.

4. PERFORMANCE SHARED VALUES:

<table>
<thead>
<tr>
<th>Shared Value</th>
<th>Excellent</th>
<th>Adequate</th>
<th>Needs Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Improvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrity/Attitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promptness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open/Clear Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Development</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. PERFORMANCE IMPROVEMENT AREAS AND COMMENTS BY THE ADVISOR:
