Integrated Science and Technology

Department of Integrated Science and Technology
   Phone: (540) 568-2789
   Website: http://msisat.jmu.edu/index.html

Academic Unit Head
   Dr. Eric Maslen

Graduate Program Director
   Dr. Ming Ivory

Professors

Associate Professors

Assistant Professors
   M. Benton, Z. Bortolot, O. Pierrakos, N. Radziwill, J. Wilson

Instructors
   R. Brent, J. Ferenbaugh, K. Newbold

Admission Criteria

The program seeks a diverse student body with grounding in basic science, engineering, mathematics, economics, political analysis, sociology, or international relations and experience in industry, government or international development. The expectation is that the applicant will have demonstrable competence in both natural and social science, by having completed a minimum of 15 semester credit hours in the natural sciences and mathematics and an equivalent amount in the social sciences or humanities, preferably related to science and technology at the undergraduate level. Work experience can be substituted for academic experience. Hence, admission to the program may be granted to students with a variety of undergraduate majors in areas such as the physical sciences, computer science, selected areas of education, engineering, operations research, and information and decision sciences.

Admission decisions will be collectively based on the following considerations:

- Graduation from a regionally accredited college or university.
- Undergraduate grade point average.
- Test scores from Graduate Record Exam (GRE), Graduate Management Admissions Test (GMAT), Medical College Admission Test (MCAT) or Miller Analogy Test (MAT).
- Official transcripts from all colleges or universities attended.
- Industrial, business, government or educational experience as indicated by current vita.
- At least two letters of recommendation.
- An original essay of 1-2 pages discussing your academic and career goals and how the ISAT program will prepare you for achieving them.

Admission in the fall term is strongly encouraged. All parts of your application should be submitted electronically, using the online application submission system.
**Mission**

The mission of the Department of Integrated Science and Technology’s (ISAT) Master's program is to provide diverse and experienced professionals with an educational experience that facilitates in-depth knowledge and skills across a variety of integrated scientific and technological disciplines utilizing a systems approach.

Among the unique characteristics of the program are:

- the curriculum and teaching methods are in constant touch with the realities of the world of work.
- the curriculum is aimed at developing graduates with strong collaborative and communicative skills.
- the graduates are skilled in information technology and knowledge management tools that are applicable to a broad range of professional careers.
- the curriculum and graduates are flexible and amenable to change in order to remain current with the nation’s developing critical technologies and with the imperatives of a changing national economy.
- the graduates solve technologically-based problems from a systems perspective, including the consideration of non-technological aspects such as politics, economics, and ethics.

The program’s sequence of core and elective courses leads to the Master of Science degree in integrated science and technology. The program builds a solid foundation in applied science and technology with a distinct theme in systems. Students acquire quantitative tools for applied systems analysis and design and for the management of technological issues encountered in contemporary professional practice. The curriculum stresses the use of computers for modeling and simulation, for the management of information and technology and for research methodology. The curriculum is unique in its incorporation of social, legal and political aspects of science and technology.

Students focus on selected areas of science and technology with practical, in-depth exposure to the size and complexity of contemporary problems. Depth will be provided through thesis or project study in one of several strategic technology areas distilled from the national critical technologies. These areas include biotechnology, information technology, manufacturing, energy and the environment. Such a class of graduates:

- apply a breadth of knowledge and skills across a variety of scientific and technological disciplines;
- effectively use formal training in collaborative and leadership methods;
- employ problem solving techniques from many disciplines and use of the computer as a problem solving tool; and
- integrate scientific and technological factors with political, social, economic and ethical considerations in problem solving.

By developing a systems approach to problem solving, the graduate will be skilled in identifying and capitalizing on the fact that most problems encountered in business or government are inherently systems problems. Characteristics of such systems involve complex interplay of technical, social, political, regulatory, and business issues; multiple, interdependent groups, units, or organizations working in coordination with sometimes conflicting needs; rapid flow of information between individuals and groups; multi-step processes for making products or decisions with ample opportunity for feedback and bottlenecks; and numerous local random events and disturbances that profoundly affect the performance of the overall system.

**Entrance, Continuation and Exit Requirements**

Prospective students should familiarize themselves with the ISAT program, and the university, the college, ISAT and the ISAT master’s curriculum. Accepted students should attend the orientation provided by the Graduate School, and arrive on campus in time to take care of ID cards, tuition payments and registration, and orientation. Graduation requires successful completion of 30 graduate credit hours in a sequence approved by the student’s graduate adviser with a GPA of 3.0 or better and with no more than six credit hours of “C’s.” Time limitations for completion of the program, continuous registration and thesis preparation will follow guidelines from The Graduate School.
Master of Science in Integrated Science and Technology

The 30-credit hour master's of science curriculum consists of 15 credit hours of common core courses followed by 15 credit hours of elective courses tailored to the individual course of study. The core component reinforces the student’s foundation in science, explores methods of research and analysis in a multidisciplinary environment, and imparts sensitivity to the social context of applying science and technology.

As part of the curriculum, students will be required to complete a six-credit thesis. This thesis can be theoretical or practical will require students to demonstrate their mastery of an integrated approach to scientific and technological issues. It may involve research, social analysis, evaluation of potential solutions, and/or design implementation.

Curriculum Components and Details

The 30 credit-hour curriculum for the Master’s of Science degree in integrated science and technology includes a 12-15 credit core program consisting of four to five courses in integrated science and technology, 12 graduate elective credits approved by the adviser, and six credits of thesis research.

Degree Requirements

<table>
<thead>
<tr>
<th>Minimum Requirements</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISAT 510. Foundations in Integrated Science and Technology</td>
<td>3</td>
</tr>
<tr>
<td>ISAT 610. Social Context of Science and Technology</td>
<td>3</td>
</tr>
<tr>
<td>ISAT 620. Introduction to Systems Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>ISAT 630. Computer Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>ISAT 640. Information and Technology Management</td>
<td>3</td>
</tr>
<tr>
<td>Approved electives</td>
<td>12</td>
</tr>
<tr>
<td>ISAT 700. Thesis</td>
<td>6</td>
</tr>
</tbody>
</table>

30-33

1 The first core course, ISAT 510, is intended for students requiring additional preparation in science, its methods and multidisciplinary problem solving.

As part of the strategic focus area, the student will be required to complete a six-credit thesis This thesis will involve research, investigation or development undertaken by students individually and/or as part of project teams.

To complete the program in one year, students must accomplish two, 12-hour semesters which represents a course overload. A student would complete two core courses and two electives per semester. Six hours of thesis, (ISAT 700), will be completed in the summer following the second semester.

Sustainable Environmental Resources Management

A version of the ISAT master’s degree is also offered jointly with the University of Malta. This thirteen-month program is offered entirely in Malta and includes the core program of four courses along with a defined set of electives. Students who complete the master’s program in Malta will also earn a master’s in sustainable environmental resources management from the University of Malta. This program is taught by faculty from both JMU and the University of Malta and includes study abroad travel.

James Madison University is accredited by the Southern Association of Colleges and Schools’ Commission on Colleges to award baccalaureate, master's and doctorate degrees. University of Malta is not accredited by the Commission on Colleges and the accreditation of James Madison University does not extend to or include the University of Malta or its students. Although James Madison University accepts certain course work in transfer toward a credential from University of Malta, or collaborates in other ways for generation of course credits or program credentials, other colleges and universities may or may not accept this work in transfer, even if it appears on a transcript from James Madison University. This decision is made by the institution subsequently considering the possibility of accepting such credits.
Course Offerings

Integrated Science and Technology

ISAT 510. Foundations in Integrated Science and Technology.
3 credits.
This course introduces the student to the fundamental concepts of science and the methodologies required for using an integrated problem-solving approach in the technical area. ISAT graduates are ineligible.

1-3 credits.
This course is intended to improve the quantitative skills of certain graduate students. Basic mathematical functions and techniques are reviewed, and linear systems topics and numerical analysis techniques introduced. The course meets in tutorial sessions for lectures, discussion and recitation. Does not satisfy graduation requirements for MS ISAT students.

3 credits.
This course will present an overview of energy generation and distribution technologies that are in use or under development. Selected technologies will be covered in detail including the underlying scientific principles. In addition, students will study tools and techniques used to measure, control and analyze energy consumption.

ISAT 525. Environmental Systems.
3 credits.
This course covers the basics of environmental pollution, processes, and control technologies. Three major areas of environmental concern (air, water and waste) are addressed. Environmental risk and decision making are discussed. Topics are presented in an integrated manner in the context of the regulatory programs. Participation in environmental projects such as impact assessment, site remediation, water quality management, air quality monitoring are required.

ISAT 528. Industrial Ecology.
3 credits.
Industrial ecology, the science of sustainability, seeks to encourage the development of a sustainable industrial society. This course introduces and examines this relatively new field of inquiry and practice. The course addresses various practical topics which are associated with industrial ecology, including life cycle assessment, design for environment and environmentally conscious manufacturing. There are additional requirements for graduate students beyond those for undergraduate students enrolled in this dual-level course.

ISAT 530. Manufacturing Systems.
3 credits.
This course covers systematic and analytical treatment of manufacturing systems to identify opportunities for improving existing systems, to design more effective systems and to improve decision-making processes in manufacturing. Topics include manufacturing systems; tools for automation and integration in manufacturing; automated process planning; technology change and strategies for implementing new technologies; and others.

ISAT 540. Information and Technology Management Systems.
3 credits.
This course focuses on the representation, manipulation, storage, and retrieval of data, information and knowledge from both a historical and contemporary perspective. Students will be introduced both to programming skills and also to introductory concepts in database design and development. The course will stress aspects of data quality, privacy, and security.

ISAT 545. Applications of GIS for Resource Management.
3 credits.
This course focuses on the use of GIS as a decision support tool in managing natural resources and promoting sustainable development practices. Applications and spatial problem-solving in the areas of energy, air and water, waste management, agriculture and coastal resources are emphasized.

3 credits.
This course is an intensive survey of the scientific foundations of biotechnology. Specific topics include the history, theory, and applications of recombinant DNA technology, genetic engineering, transgenic organisms, and the role of biotechnology in society.
3 credits.  
The amount of DNA sequence data being collected today is increasing rapidly. The student will learn, through lectures and hands-on laboratory exercises, a compendium of algorithms that can search for sequence similarities, create alignments for finding consensus sequences, model three-dimensional structures and more. Prerequisites: ISAT 340, ISAT 351, and ISAT 454 (or their equivalents), or permission of the instructor (requires knowledge of Molecular Biology and database technology).

ISAT 560. Complex Systems and How They Fail.  
3 credits.  
This course provides an interdisciplinary study of complex system operation and failure focusing on real-world critical infrastructure (e.g., energy, telecommunications, health) systems functionality and problems. Based on known threats and hazards, cascading failures that can result in unexpected catastrophes are analyzed. Risk concepts and management strategies are examined.

2 credits.  
This course focuses on the exploration and analysis of case studies in the development of sustainable energy policies and practices around the world, including renewable and non-renewable energy sources and conservation practices. Connections of energy sustainability to other key areas, such as water, air and waste, agriculture and food and coastal resources will be emphasized. Offered in Malta.

2 credits.  
This course focuses on the exploration and analysis of case studies in the development of sustainable air and water policies and practices around the world, including air pollution abatement, waste disposal and the interconnection of air and waste. Connections of air and water sustainability to other key areas, such as water, energy, agriculture and food and coastal resources will be emphasized. Offered in Malta.

2 credits.  
This course focuses on the exploration and analysis of case studies in the development of sustainable agriculture and food security policies and practices around the world, including food safety and land use. Connections of agricultural sustainability to other key areas, such as water, energy, air and waste and coastal resources will be emphasized. Offered in Malta.

2 credits.  
This course focuses on the exploration and analysis of case studies in the development of sustainable water policies and practices around the world, including potable water supply and production and water pollution. Connections of water sustainability to other key areas, such as agriculture and food, energy, air and waste and coastal resources will be emphasized. Offered in Malta.

2 credits.  
This course focuses on the exploration and analysis of case studies in the development of sustainable marine and coastal resources policies and practices around the world, including pollution, development and marine food supply. Connections of marine and coastal sustainability to other key areas, such as agriculture and food, energy, air and waste and water will be emphasized. Offered in Malta.

ISAT 570. Telecommunication Systems.  
3 credits.  
This course covers the science, technologies and regulation of established as well as emerging telecommunications systems. Included are network design and planning, as well as information and infrastructure security. Student course work will include laboratory experience.

ISAT 571. Interaction Design.  
3 credits.  
Processes, principles, tools, models, and techniques for designing interactions between humans and digital products and systems. Students will learn through directed reading, design exercises, heuristic design evaluations and empirical studies of designs.
ISAT 580. Readings and Research.  
1-3 credits.  
This course will allow graduate and advanced undergraduate students to undertake intensive study of selected topics that are of special interest. May be repeated when content changes. Prerequisite: Permission of instructor.

ISAT 610. Social Context of Science and Technology.  
3 credits.  
Critical perspectives on the economic and political systems as they affect scientific research and technological activity in the U.S. and the world. Case studies of major public policy debates involving science and technology. Identifying institutional players and their value commitments, describing political relationships among players, and designing dynamic solutions to social context dilemmas.

ISAT 620. Introduction to Systems Dynamics.  
3 credits.  
An introduction of applied systems analysis approach to problem solving in a multidisciplinary context. Applications taken from biotechnology, energy, environment, health, information management and manufacturing. Topics include introduction to systems analysis and its application to social systems, technological systems, and systems in nature; systems characterization and optimization; advanced project management.

3 credits.  
Use of simulation tools to understand and optimize commonly occurring systems in the concentration areas. Development of simulation models, validation of models, and use of models to aid decision making. Topics include: applicability and limitations of simulation models; the model-building process; discrete-event models; dynamic models; deterministic and stochastic models; system optimization and validation.

ISAT 640. Information and Technology Management.  
3 credits.  
This course focuses on the acquisition, representation, storage, retrieval, and distribution of data, information and knowledge from both a historical and contemporary perspective. It places special emphasis on IKM technology in science and technology and the information economy, the management of data, information, and knowledge as critical enterprise assets. Students will study computer systems as tools for information and knowledge management and examine ethical, legal, and social issues in the management of data, information, and knowledge, including intellectual property, privacy, and security.

ISAT 650. Advanced Integrated Science and Technology.  
3 credits.  
This course focuses on applied science and technology applications for K-12 teachers and industry trainers. Students will develop and assess sources of information on applied science and technology and develop inquiry-based activities to incorporate new issues in applied science and technology into existing curricula.

3 credits.  
The course will introduce the policy process affecting regulation and deregulation of various industries. Study of the theory behind and the institutional forms of regulation will be supplemented by case studies of specific industries. The course will also look at international politics and trade as they affect regulatory regimes globally. Prerequisite: ISAT 610.

3 credits.  
Focuses on the life-cycle model of systems design and development. Includes concepts related to data modeling, economic evaluation, optimization methods, human factors, queuing theory, system test and evaluation, and design validation techniques. Object-oriented analysis and design considerations emphasized. Prerequisite: ISAT 630.

ISAT 654. Advanced Technology Management.  
3 credits.  
This course will introduce students to methods, tools, and techniques for effective management of technology development and application including management of technology within a company; R&D management; Test and Evaluation procedures and metrics; investment strategies; intellectual property issues; fostering entrepreneurialism; managing innovation; and technology transfer. The course will also address managing technology as a tool, e.g., equipment modernization. Prerequisite: ISAT 640.
ISAT 655. Technology Assessment.  
3 credits.  
This course will introduce students to the theory and methods of technology assessment and transfer. Students will apply techniques such as risk analysis, cost-benefit analysis, forecasting, trend impact analysis, and technology sequence analysis to assess the impacts of new technologies on society. In addition, students will study the process of technology innovation, diffusion, and transfer in the context of both developed and developing nations. Prerequisite: ISAT 620.

3 credits.  
This course examines the organizational and technological foundations of information systems in a production operations setting. Topics include selecting and implementing tools and systems, database management, information integration, production planning and execution systems, supply chain integration and management, and managing system security. Prerequisite: ISAT 640 or permission of instructor.

ISAT 658. International Contexts of Science and Technology.  
3 credits.  
This course will make students aware of the global nature of scientific and technological decision-making and sensitive to the impact of culture on science and technology issues. Research and development system of the United States is placed in a global context. A comparative study of the R&D systems around the world is done. International technical issues, where solutions transcend political boundaries, are covered.

ISAT 680. Reading and Research.  
1-3 credits.  
Opportunity for supervised reading and research in areas of special interest to the student. Reading and research may be done only in the major field of study.

1 credit.  
The course prepares students for planning and completing their master's thesis. Topics include problem definition, research question, literature review, research methods, and thesis planning process. All students draft a thesis proposal. The course must be completed within the first 12 credit hours of the student’s program of study. Prerequisite: ISAT 620 or instructor approval.

ISAT 698. Comprehensive Continuance.  
1 credit.  
Continued preparation in anticipation of the comprehensive examination. Course may be repeated as necessary.

2 credits.  
Students completing registration for the maximum number of hours of project credit are required to register for continuance each semester, including summer, until they have received their degree. Continuance credits carry no credit hour production and do not count toward graduate program requirements.

ISAT 700. Thesis Research.  
6 credits.  
A research thesis with an emphasis in the student’s designated strategic area, but integrated with at least one other area. The thesis will report the results of original research undertaken individually by the student. This course is graded on a satisfactory/unsatisfactory/incomplete (S/U/I) basis.