

# INFORMATION TECHNOLOGY, PHD

**Banner Code: VS-PHD-INFT**

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Information Technology (INFT) is a multidisciplinary PhD program that spans all of the research areas available within the School of Engineering, as well as collaboration with faculty across the campus. The Information Technology PhD program emphasizes the particular aspects of technology located in the Northern Virginia Technology Corridor and around the globe. The relevance of the INFT doctoral program has grown significantly as the world has become more dependent on the effective use of information. Our focus on the science, engineering, and technology of information processing complements and enhances traditional approaches to engineering that are more strongly based on the physical and material sciences. The Information Technology PhD program is broad, and can be customized to support individual research interests.

Students are encouraged to enter into an established concentration to provide focus to their program.

## Admissions & Policies

### Admissions

#### Requirements

Students are selected on the basis of scholarship and potential from among applicants with appropriate degrees from institutions of high standing.

Generally, a background in an information technology-related area, such as engineering, computer science, operations research, mathematics, and physical sciences is required for admission to the doctoral program. However, in some instances, well-qualified students without a clearly related prior degree (i.e., MS in Information Technology Management, MBA) may be offered admission. Most successful applicants already have a Master's degree, however exceptionally qualified individuals without an MS may be accepted, but will be required to take more courses.

An undergraduate GPA of 3.00 and a graduate GPA of 3.50 are basic requirements for applicants. Applicants are required to submit: an online application for admission, undergraduate and graduate transcripts from previous colleges and universities, GRE test results, three letters of reference (preferably from college instructors), a résumé, a personal goal statement, and to identify research areas of interest. Foreign transcripts must be translated and evaluated (course-by-course preferred) by a member of the NACES Membership. Evaluations can also be done by George Mason University, at no extra cost to the applicant; however, this typically adds 6-8 weeks to the application processing time. Please review George Mason University's Policy on International Transcript Submission. An applicant's entire background is examined before an admission decision is made.

To ensure a common ground of fundamentals, students should have a background in such topics as calculus, differential equations, linear algebra, discrete structures, probability, and statistics. In addition, students entering the PhD in Information Technology Program must

have a sound working knowledge in computing as demonstrated by examples of programs or applications developed and tested in at least one high level programming language environment. Because much of the coursework within this program requires computational proficiency, experience with a variety of languages and computer hardware is useful as is an understanding of computer architecture. Highly-qualified students who do not present evidence of appropriate coursework may be admitted and then required to take appropriate articulation courses.

Those who wish to be considered for Mason's Presidential Scholarship, which provides a stipend and tuition support for three years, must be full-time students, with a minimum GPA of 3.5 or higher in their most recently earned degree, and submit GRE scores with a combined math and verbal score of 1200 on exams taken prior to August 1, 2011; combined score of 310 on the new revised GRE scale for exams taken August 1, 2011 and beyond. Scores must have been earned within the last five years. Only one Presidential Scholarship is awarded per PhD program per year.

### Policies

The general doctoral requirements of Mason apply to this program.

#### Reduction of Credit

Students must complete a minimum of 72 graduate credits, which may be reduced by a maximum of 30 credits from an approved and completed master's degree. Reduction of credit requires the approval of the program director/dean or designee of the school. They determine whether the credits are eligible for reduction of credit and applicable to the degree program and the number of credits to be reduced.

#### Program Requirements

Information Technology doctoral candidates must earn a minimum of 72 graduate credits. The program is made up of a breadth requirement (assessed via qualifying exams) and specialized coursework (assessed via the comprehensive exam), followed by preparation of a dissertation proposal, an original research project, and final defense. To advance to candidacy, students must complete all coursework, pass the qualifying and comprehensive examinations, and defend a dissertation proposal.

## Requirements

### Degree Requirements

Total credits: minimum 72

The degree plan outlined here is based on a student who receives a full 30 credit reduction. Students who do not receive a full credit reduction will be required to choose additional credits in consultation with their advisors.

#### Plan of Study

Students are strongly encouraged to select a concentration area. However, the ability exists to progress with only a plan of study. Students who declare a concentration will have the concentration noted on their transcript. The plan of study is a well-defined set of advanced courses in a focused area. Successful completion of this requirement should enable the student to do basic or applied research in a significant contemporary area in IT.

The 18 credits of graduate-level coursework must fulfill the following requirements:

- Coursework must be independent of the courses students take to prepare for the qualifying exams.
- Courses that cannot be included in any plan of study are any INFS 500-level courses; certain AIT courses; OR 540 Management Science; STAT 535 Analysis of Experimental Data; and SYST 500 Quantitative Foundations for Systems Engineering. Exceptions must be approved in advance by the senior associate dean.
- At least 12 of the 18 credits must be in courses numbered 700 or higher, and these 12 credits cannot include directed reading, project, or thesis courses.
- A cumulative GPA of 3.50 is required in courses taken in the plan of study.

## Concentrations

### Available Concentrations

- Digital Forensics (DFOR)
- Information Sciences and Technology (ISTC)
- Information Security and Assurance (ISA)
- Information Systems (ISYS)
- Mechanical Engineering (ME)
- Software Engineering (SWE)

### Digital Forensics (DFOR)

Code	Title	Credits
AIT 701	Cyber Security: Emerging Threats and Countermeasures	18
CFRS 661	Digital Media Forensics	
CFRS 663	Operations of Intrusion Detection for Forensics	
CFRS 664	Incident Response Forensics	
CFRS 730	Forensic Deep Packet Inspection	
CFRS 760	Legal and Ethical Issues in IT	
CFRS 761	Malware Reverse Engineering	
CFRS 762	Mobile Device Forensics	
CFRS 763	Registry Forensics - Windows	
CFRS 764	Mac Forensics	
CFRS 767	Penetration Testing in Computer Forensics	
CFRS 768	Digital Warfare	
CFRS 769	Anti-Forensics	
CFRS 770	Fraud and Forensics in Accounting	
CFRS 771	Digital Forensic Profiling	
CFRS 772	Forensic Artifact Extraction	
CFRS 773	Mobile Application Forensics and Analysis	
CFRS 775	Kernel Forensics and Analysis	
CFRS 780	Advanced Topics in Computer Forensics <sup>1</sup>	
CFRS 790	Advanced Computer Forensics <sup>1</sup>	
ECE 611	Advanced Computer Architecture	
ECE 645	Computer Arithmetic	

ECE 646	Applied Cryptography	18	
ECE 746	Advanced Applied Cryptography		
ISA 650	Security Policy		
ISA 652	Security Audit and Compliance Testing		
ISA 656	Network Security		
ISA 674	Intrusion Detection		
ISA 785	Research in Digital Forensics <sup>1</sup>		
IT 796	Directed Reading and Research <sup>1</sup>		
Total Credits			18

<sup>1</sup> Can only be taken once for PhD credit in the digital forensics concentration.

Note:

Where appropriate and with doctoral advisor approval, a maximum of two emphasis courses may be substituted with relevant courses from other Volgenau School departments. The student's overall coursework must satisfy the University requirement for the PhD in Information Technology.

### Information Sciences and Technology (ISTC)

Code	Title	Credits	
Select at least 18 credit hours from the following with no more than two courses (6 credit hours) taken at the 500 or 600 levels:		18	
AIT 582	Metadata Analytics for Big Data	18	
AIT 614	Big Data Essentials		
AIT 624	Knowledge Mining from Big-Data		
AIT 701	Cyber Security: Emerging Threats and Countermeasures		
AIT 711	Rapid Development of Scalable Applications		
AIT 716	Human Computer Interaction		
AIT 724	Data Analytics in Social Media		
AIT 734	Advanced Web Analytics Using Semantics		
Other VSE courses with the approval of an advisor or program director.			
Total Credits			18

### Information Security and Assurance (ISA)

Code	Title	Credits
Students must take at least 18 credit hours, of which 12 credits must be numbered 700 and above, and with at least 12 credits from the following:		18
ISA 673	Operating Systems Security	18
ISA 674	Intrusion Detection	
ISA 681	Secure Software Design and Programming	
ISA 697	Topics in Information Security	
ISA 763	Security Protocol Analysis	
ISA 764	Security Experimentation	
ISA 796	Directed Readings in Information Security	
ISA 862	Models for Computer Security	
ISA 863	Advanced Topics in Computer Security	
CS 700	Research Methodology in Computer Science	

Any CS, INFS or SWE course numbered 700 or higher, subject to the approval of the student's academic advisor	
Total Credits	18

### Information Systems (ISYS)

Code	Title	Credits
Select at least 18 credit hours, with at least 12 credits in INFS or ISA courses numbered 700 or higher as follows:		12

INFS 623	Web Search Engines and Recommender Systems	
INFS 740	Database Programming for the World Wide Web	
INFS 760	Advanced Database Management	
INFS 770	Knowledge Management for E-Business	
INFS 772	Intelligent Agents and the Semantic Web	
INFS 774	Enterprise Architecture	
INFS 796	Directed Readings in Information Systems	
ISA 562	Information Security Theory and Practice	
ISA 656	Network Security	
ISA 797	Advanced Topics in Information Security	

Select the remaining 6 credits from SWE and CS courses in Software Engineering and Computer Science: <sup>1</sup>

SWE 721	Reusable Software Architectures	6
SWE 763	Software Engineering Experimentation	
SWE 796	Directed Readings in Software Engineering	
SWE 821	Software Engineering Seminar	
CS 583	Analysis of Algorithms	
CS 657	Mining Massive Datasets with MapReduce	
CS 688	Machine Learning	
CS 700	Research Methodology in Computer Science	
CS 782	Advanced Machine Learning	
CS 787	Decision Guidance Systems	
CS 880	Research Topics in Artificial Intelligence	
CS 811	Research Topics in Machine Learning and Inference	

Total Credits 18

<sup>1</sup> Students without a credit reduction should select the remaining credits from any 600 level or higher INFS, ISA, CS or SWE courses or courses approved in advance by the student's academic advisor.

### Mechanical Engineering (ME)

Courses that constitute a student's plan of study should be chosen in consultation with the student's advisor and/or dissertation committee.

Code	Title	Credits
Students must take a minimum of 18 credit hours, with at least 12 credits numbered 700 or higher:		
600/700-level courses outside the ME department (typically physics, mathematics, etc.)		6
700-level courses within the ME department in subjects within the student's area of specialization		6

700-level courses within the ME department in subjects outside the student's area of specialization	6
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Available courses include:

ME 621	Foundations of Fluid Mechanics
ME 722	Introduction to Turbulence
ME 714	Fracture Mechanics
ME 715	Impact Dynamics

Total Credits 18

### Software Engineering (SWE)

Code	Title	Credits
Select at least 18 credit hours with at least 12 credits at the 700 level as follows:		12

SWE 763	Software Engineering Experimentation	
or CS 700	Research Methodology in Computer Science	
SWE 721	Reusable Software Architectures	
SWE 737	Advanced Software Testing	
SWE 760	Software Analysis and Design of Real-Time Systems	
SWE 795	Advanced Topics in Software Engineering	
SWE 796	Directed Readings in Software Engineering	
SWE 798	Research Project	
SWE 825	Special Topics in Web-Based Software	

Select 6 credits from the following: 6

SWE 619	Object-Oriented Software Specification and Construction
SWE 620	Software Requirements Analysis and Specification
SWE 621	Software Design and Architecture
SWE 622	Distributed Software Engineering
SWE 631	Software Design Patterns
SWE 632	User Interface Design and Development
SWE 637	Software Testing
SWE 642	Software Engineering for the World Wide Web
SWE 645	Component-Based Software Development
SWE 681	Secure Software Design and Programming
CS 706	Concurrent Software Systems
INFS 740	Database Programming for the World Wide Web
INFS 760	Advanced Database Management
INFS 770	Knowledge Management for E-Business
INFS 797	Advanced Topics in Information Systems
ISA 562	Information Security Theory and Practice
ISA 656	Network Security
ISA 763	Security Protocol Analysis
ISA 764	Security Experimentation
ISA 862	Models for Computer Security

Total Credits 18

## Breadth Requirement

To satisfy the breadth requirements of the PhD INFT, a student must demonstrate his/her proficiency in the foundational knowledge specific to her/his program of study. This is satisfied through completion of two Fundamental Knowledge courses, and two Qualifying Exams. The Fundamental Knowledge courses and the Qualifying Exams are listed in the study guide maintained by the Volgenau School of Engineering (VSE) Graduate Programs administrative office. Selection of the two Fundamental Knowledge courses and the two Qualifying Exams must be approved by the student's PhD advisor and submitted to the VSE Graduate Programs administrative office.

**Time limits:** Students who enter the program with a 24-30 credit reduction from a prior Master's degree must satisfy all breadth requirements no later than twelve months following the end of their fourth semester in the program. Students who enter the program with a reduction of less than 24 credits must satisfy all breadth requirements no later than twelve months following the end of their sixth semester in the program. In both instances, these time limits include all attempts at the Fundamental Knowledge courses and the Qualifying Exams. Time limits apply to all PhD INFT students, regardless of their part-time or full-time study status. Failure to satisfy all breadth requirements by the specified time is cause for termination from the PhD INFT program.

**Fundamental Knowledge course requirement:** Students are required to complete two Fundamental Knowledge courses within the first 24 months of their PhD enrollment, regardless of their part-time or full-time study status and regardless of credit reductions from previous coursework. Fundamental Knowledge courses are listed in the study guide maintained by the VSE Graduate Programs administrative office. Fundamental Knowledge courses must be approved by the PhD advisor; must be specific to the student's program of study; and must be submitted to the VSE Graduate Programs administrative office. These courses can be used as credit toward the student's plan of study, but will not count toward his/her 700 level minimum requirement.

Students must earn a grade of A- or better in both Fundamental Knowledge courses on their first attempt to satisfy this component of the breadth requirement. Students failing to earn a grade of A- or better on their first attempt in one or both Fundamental Knowledge courses are required to take and pass in one attempt, supplementary Qualifying Exams. Supplementary Qualifying Exams must cover the bodies of fundamental knowledge associated with the Fundamental Knowledge courses in which the student earned a grade of less than A-. Supplementary Qualifying Exams are in addition to the two Qualifying Exams required and described below. All Qualifying Exams, including supplementary Qualifying Exams, must be completed within the period defined above under Time Limits.

**Qualifying Exam requirement:** Students satisfying the Fundamental Knowledge course requirement described above are required to take and pass two Qualifying Exams within the period defined above under Time Limits. Qualifying Exams are listed in the study guide maintained by the VSE Graduate Programs administrative office. Selection of Qualifying Exams must be approved by the PhD advisor; must be specific to the student's program of study; must not duplicate the bodies of knowledge of the student's Fundamental Knowledge courses described above; and must be submitted to the VSE Graduate Programs administrative office.

Qualifying Exams are offered twice a year just before the fall and spring semesters. Each exam is allocated two hours and graded on a pass or fail basis using a double blind procedure. Students must take all required Qualifying Exams in their first attempt. Students failing one or both of

their Qualifying Exams on the first attempt are required to retake the Qualifying Exams they did not pass, the next time the Qualifying Exams are offered. Students failing Qualifying Exams may not subsequently satisfy the breadth requirement by completing Fundamental Knowledge courses covering the same bodies of knowledge. Failure to satisfy all breadth requirements, including the Qualifying Exams, within the period defined above under Time Limits, is cause for termination from the PhD INFT program.

Students failing to earn a grade of A- or better in one or both Fundamental Knowledge courses are required to take and pass supplementary Qualifying Exams in the bodies of knowledge covered by the Fundamental Knowledge courses in which they earned a grade of less than A-. Supplementary Qualifying Exams are in addition to the two required Qualifying Exams described above. Students must pass supplementary Qualifying Exams in one attempt only. Failure to satisfy all breadth requirements, including all Qualifying Exams, within the period defined above under Time Limits, is cause for termination from the PhD INFT program.

## Dissertation Research

Code	Title	Credits
IT 990	Dissertation Topic Presentation	1
Select 23 additional credits from the following:		23
IT 998	Doctoral Dissertation Proposal	
IT 999	Doctoral Dissertation (minimum 12 credits required)	
Total Credits		24

## Doctoral Supervisory Committee

On admission to the program, students are assigned a temporary academic advisor. Students are responsible for working with the temporary advisor until they choose a dissertation director and establish a doctoral supervisory committee.

The doctoral supervisory committee includes the dissertation director, who must be a member of the Mason graduate faculty, and at least three other people from the Mason graduate faculty. The dissertation director and chair of a PhD in INFT dissertation committee must have at least a 50% appointment in the Volgenau School. This rule does not apply to a co-director, provided that the chair and other co-director satisfies the "at least 50% rule." At least three committee members must be from the Volgenau School, and at least two of the departments of the Volgenau School must be represented on this committee.

In addition, industrial representatives and faculty members from departments outside the school are highly desirable, but not required, on the committee. The doctoral supervisory committee administers the comprehensive exam, dissertation proposal presentation, and the dissertation predefense and defense. Permission for the comprehensive exam and dissertation defense are requested from the Volgenau School associate dean on the basis of a written request and plan that has been approved by the supervisory committee.

## Comprehensive Exam

The comprehensive exam is an oral exam taken after students have satisfactorily completed all coursework requirements in their approved plan of study. To initiate the exam process, the student meets with the dissertation advisor to prepare a permission form, which has to be approved by the entire dissertation supervisory committee one

month prior to the exam, to be forwarded to the associate dean for final approval. The permission form must be submitted with:

1. a one page description of the intended area of research; and
2. a reading list on which the student will be examined.

The reading list should include articles and/or books that cover the fundamentals, state-of-the-art, and tools needed to perform research in the intended area.

The objective of the comprehensive exam is to allow the dissertation supervisory committee to assess the student's readiness to complete doctoral research in an area of concentration. The duration of the oral exam is typically two hours. Students who fail the exam are allowed to retake it once. Failure in the second attempt results in termination from the program. Students must pass the comprehensive exam and dissertation proposal defense before being advanced to candidacy. The comprehensive exam must be attempted for the first time no later than one year after completing all coursework requirements (excluding IT 990 Dissertation Topic Presentation, IT 998 Doctoral Dissertation Proposal, and IT 999 Doctoral Dissertation).

### **Dissertation Proposal Presentation**

Near the end of the coursework, doctoral students prepare a written dissertation proposal to present to the doctoral supervisory committee. The proposal must be delivered to the doctoral supervisory committee at least two weeks before the presentation. Students should enroll in IT 998 Doctoral Dissertation Proposal to complete this effort (note: students must pass the qualifying exams before enrolling in IT 998 Doctoral Dissertation Proposal). During the term the student expects to present the dissertation proposal to the committee (or perhaps the prior term), the student should enroll in IT 990 Dissertation Topic Presentation. The dissertation proposal presentation must be at least one week after passing the comprehensive exam. After successfully completing the dissertation-proposal requirement, the student is formally admitted as a candidate for the PhD degree. The application for candidacy is submitted to the associate dean on a standard form.

### **Dissertation and Final Defense**

With the concurrence of the dissertation supervisory committee, students proceed with the doctoral research, during which time they must be continuously enrolled in IT 999 Doctoral Dissertation. When the central portions of the research have been completed to the point that students are able to describe the original contributions of the dissertation effort, they submit the written dissertation to the committee and schedule an oral predefense to the committee. The predefense is to be held no sooner than one month after members of the committee have copies of the dissertation. Once the committee believes the student is ready, a final public oral defense may be scheduled no sooner than one month after the conclusion of the predefense so that the announcement is posted for at least two weeks. The entire dissertation committee and the associate dean must be present at the defense, unless an exception is approved by the associate dean in advance of the defense.

Following satisfactory evaluation of the oral defense of the dissertation by the committee, the student must prepare, with supervision from the dissertation director, a final publishable dissertation that represents a definitive contribution to knowledge in IT. If the candidate successfully defends the dissertation, the dissertation committee recommends that the final form of the dissertation be completed and the Volgenau School faculty and the graduate faculty of Mason accept the candidate for the PhD degree.

If the student fails to successfully defend the dissertation, the student may request a second defense, following the same procedures as for the initial defense. There is no time limit for this request other than general time limits for the doctoral degree. An additional predefense is not required, but students are strongly advised to consult with the committee before scheduling a second defense. If the student fails on the second attempt to defend the dissertation, the student will be terminated from the program.