MS and Ph.D. Programs in ISEM (Information Systems Engineering & Management)

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Executive Overview

We are living in an increasingly digital world that is dominated by the *Digital Enterprises* (i.e., the organizations where nearly all significant business processes and relationships with customers, suppliers, and employees are digitally enabled and key corporate assets are managed through digital means). For example, in 2017, the top 5 companies on the Wall Street have been high tech companies such as Google, Amazon, Apple, and General Electric. These digital enterprises are not one dimensional entities that are just exploiting mobile apps but in fact are simultaneously pushing the envelope in multiple dimensions that include Web, Outsourcing, Mobility, Security, Data, Globalization, AI, and Analytics (see Figure 1).
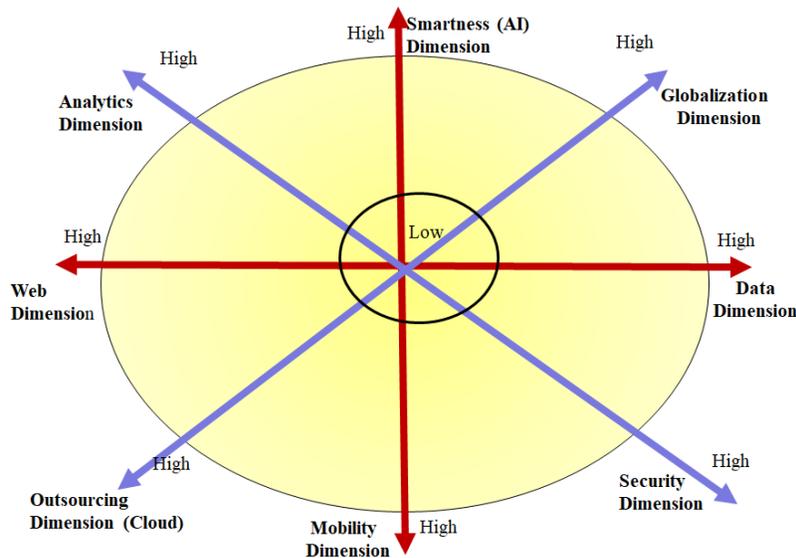

Figure1: The Key "Mega Technologies" that are Driving Digital Enterprises (Source: Umar 2018). *Note: The center represents low and the outer circle represents high dependence.*

The MS and Ph.D programs in Information Systems Engineering and Management (ISEM) at Harrisburg University of Science and Technology are designed to educate the leaders who can plan, engineer/re-engineer, and manage the next generation of digital enterprises. The Next Generation Enterprises (NGEs), as depicted in Figure1 in the outermost circle, compete and succeed in the marketplace by leveraging technology and evidence based decision making to anticipate and address customer needs in real time. For example, the large number of Smart Cities initiatives such as the United Nations New Urban Agenda are heavily relying on the aforementioned technologies to address urgent issues in health, education, public safety, public welfare, transportation, agriculture, energy and the environment. Thus, Smart Cities are becoming NGEs. Another significant development in NGEs is the emerging Industry4.0 that represents smart factories based on IIoTs (Industrial Internet of Things) and industrial robotics.

Similar developments in Smart Health, Smart Agriculture, Smart Energy Grids and other NGE models offer unprecedented opportunities for modern organizations to make strategic decisions based on latest business and strategic intelligence. However, these opportunities also raise serious technical, business and social challenges that could threaten our life styles if not managed properly. The graduate studies in ISEM at Master's and Doctorate levels at HU are intended to prepare well rounded practitioners and scholars whose knowledge cuts across the following three areas:

1. *Information Systems*: latest digital technologies and innovations as represented by the eight dimensions (e.g., web-based components, mobile computing and wireless communications, IoTs, secuity technologies, business analytics, and artificial intelligence).
2. *Systems Engineering*: systems thinking and emphasis on systems instead of individual components so that the interactions and tradeoffs between people, processes and technologies are fully leveraged to build smart solutions based on solid business and strategic intelligence.
3. *Management:* innovative business strategies, entrepreneurship, planning, integration, security, governance and project management to assure that the NGEs are well aligned to the user needs and well managed for long range growth.

ISEM at MS and Ph.D. levels are unique interdisciplinary programs that emphasize the entire Learn, Plan, Do, Check (LPDC) cycle instead of one narrow area of work. The Program Goals of the Ph.D. in ISEM are that our graduates should be able to:

- Serve as thought leaders and visionaries in planning, engineering/re-engineering and management of the next generation of digital enterprises.
- Conduct original research on the impact of digital innovations on the enterprises and work force of the future.
- Push the envelope of *interdisciplinary knowledge* in three active areas of work (information systems, systems engineering, and management) towards a globally sustainable environment.

HU's ISEM MS and Ph.D. graduates are uniquely equipped to ideate and lead the creation of NGEs as well as the transformation of existing enterprises and organizations into NGEs. They are well prepared to effectively manage NGEs and to respond to ever-changing environments.

Quick Description of Advanced Studies in ISEM at HU

The ISEM Advanced Studies Program at Harrisburg University focuses on enabling students to make original contributions to their respective fields of study. The new Ph.D. in ISEM emphasizes a strong foundation in information systems engineering, innovative research, and applications of research. Doctoral candidates are required to complete six doctoral-level courses (700-level, 18 semester hours); six semester hours in a formal research seminar; and 12 semester hours of dissertation work. A total of 72 semester hours of coursework and research is required beyond the baccalaureate degree, including 36 semester hours at the master's level. A conceptual overview of the Ph.D. Program is shown in Figure2.

The MS in ISEM program, displayed in Exhibit1, was introduced in 2010 and currently has over 1000 students. It consists of 36 credit hours (12 courses) that are subdivided into the following:

- Five core required courses that provide a mixture of technical and management topics
- Five electives that can be chosen from a large pool of courses in diverse topic areas. The students may select five electives from any of these topic areas to build their own specialization or choose to specialize in predetermined topic areas
- Two capstone courses that allow the students to synthesize their knowledge into an experiential project or a research thesis
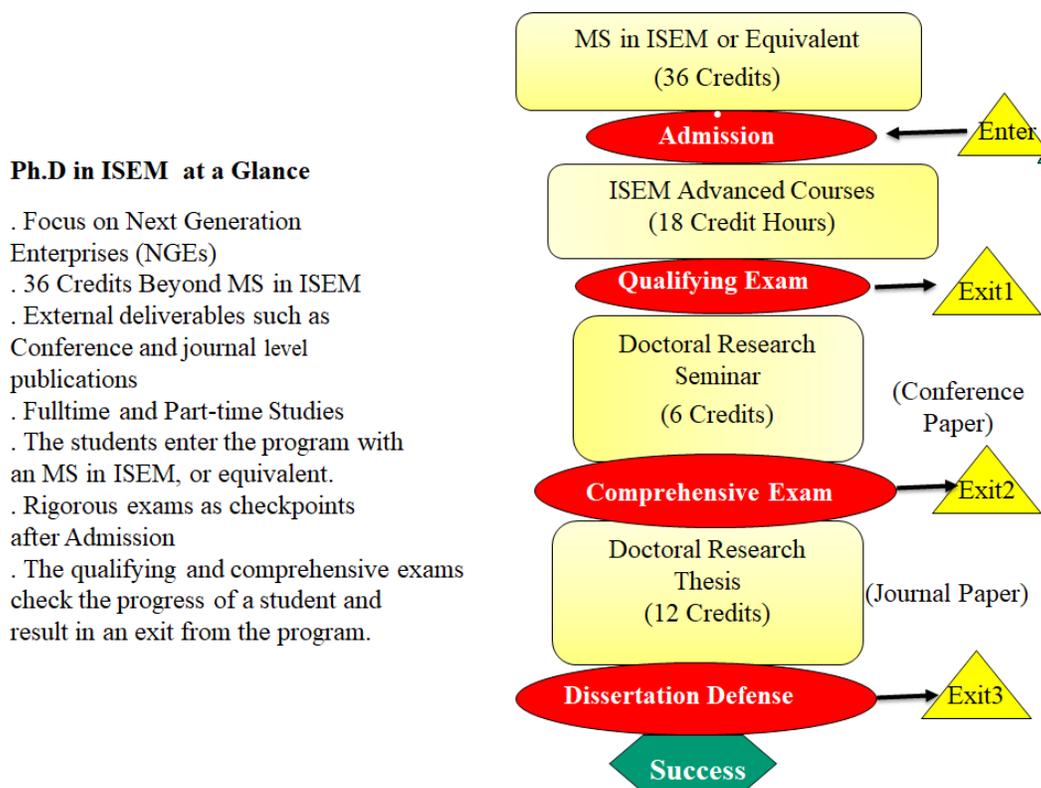
Ph.D in ISEM at a Glance

. Focus on Next Generation Enterprises (NGEs)
. 36 Credits Beyond MS in ISEM
. External deliverables such as Conference and journal level publications
. Fulltime and Part-time Studies
. The students enter the program with an MS in ISEM, or equivalent.
. Rigorous exams as checkpoints after Admission
. The qualifying and comprehensive exams check the progress of a student and result in an exit from the program.

MS in ISEM or Equivalent (36 Credits) → Admission ← Enter
ISEM Advanced Courses (18 Credit Hours) → Qualifying Exam → Exit1
Doctoral Research Seminar (6 Credits) (Conference Paper) → Comprehensive Exam → Exit2
Doctoral Research Thesis (12 Credits) (Journal Paper) → Dissertation Defense → Exit3
Success

Figure 2: Highlights of Doctoral Studies in ISEM

ISEM Doctorate Admission Requirements

A faculty admission committee will evaluate each applicant's candidacy once all admissions materials have been received. The doctorate admission process requires the candidate to:

- Complete the application online at www.HarrisburgU.edu/Apply.
- Write an essay (in English) that clearly indicates the motivation for pursuing doctorate studies and the topics of primary research interest to the candidate.
- Submit final official transcript(s) from the college or university at which the highest degree earned was conferred.
- Submission of an official record of Graduate Record Examination (GRE) scores.
- Provide two letters of recommendation from academic or industry professionals.
- Submit a resume or by email to Admissions@HarrisburgU.edu.
- Interview with Faculty Admission Committee.

All Applicants to the ISEM Ph.D. Program must have an MS in ISEM (or equivalent) with knowledge equivalent to ISEM503 (Artificial Intelligence Principles and Applications), ISEM525 (Business Process Modeling and Workflow), and Mgmt531 (Business Entrepreneurship Principles) and a research thesis or a published research paper relevant to the MS. Interested students may enroll in the MS ISEM program to satisfy these requirements before applying to the ISEM Ph.D. program. Priority consideration will be given to those applicants with a GRE score in the 80th percentile or above and a GPA of 3.5 or above.

Preparing for Admission in the Ph.D. Program in ISEM

Admission in the ISEM Ph.D Program is very competitive due to limited seats in the program. Before applying to the Program, you must make sure that you:

- Maintain a high GPA in your ISEM courses (minimum is 3.5)
- Take the following required ISEM courses (ISEM500, MGMT510, ISEM540 (or equivalent for PMGT students) and ISEM530 (or equivalent for PMGT students).
- Take the following ISEM elective courses (ISEM503, ISEM525 and MGMT531).
- Select a research thesis in your Capstone. You may be asked to include your thesis in the admission materials
- Improve your written communication skills (your TOEFL score must be high)
- Decide if you want to pursue the Ph.D part-time or fulltime. A few scholarships are offered to exceptionally qualified fulltime students. If you are pursuing a part-time Ph.D. then you must make sure that your work is related to your research topic (i.e., your work should complement and enrich your Ph.D. research).

Ph.D. Program in ISEM at a Glance

Doctorate education focuses on enabling students to make original contributions to their respective fields of study. Figure3 illustrates the overall structure of the ISEM Ph.D. Program:

Entering Students
- CS/IT
- Engg (EEs, MEs, AE, CEs)
- Sciences
- Business
- Others (Pharmacy, Law, Design, etc)

Sources for PhD Hard Problems
- MIT Sloan Management Review Special Issues
- Harvard Business Review Special Publications
- IEEE Transactions on Engg Management
- IEEE Publications on Emerging Techs
- US DARPA Announcements
- Other US Federal Research
- Announcements (NSF, NIH, NIST, etc)
- Special Journal issues e.g Industry 4.0
- United Nations SDGs and Agendas
- European, Australian, Chinese, Korean Research Agendas
- Major Industry Trends as pointed out by Gartner, Accenture, Deloitte and other IT consulting organizations

ISEM PhD Program
- **Research Papers**
- **Ph.D Thesis**

Research Paradigms/Approaches

Behavioral Science:
- Propose and verify theories
- Goal: explain or predict behavior.

Design-science paradigm
- Extend the capabilities
- Goal: Create innovative artifacts.

Hard Science (e.g., experimental physics)

Mixtures

Sample Research Questions
- Impact of AI on future workforce
- Impact of industry4.0 on global economy
- Use of latest digital innovations for poorest populations
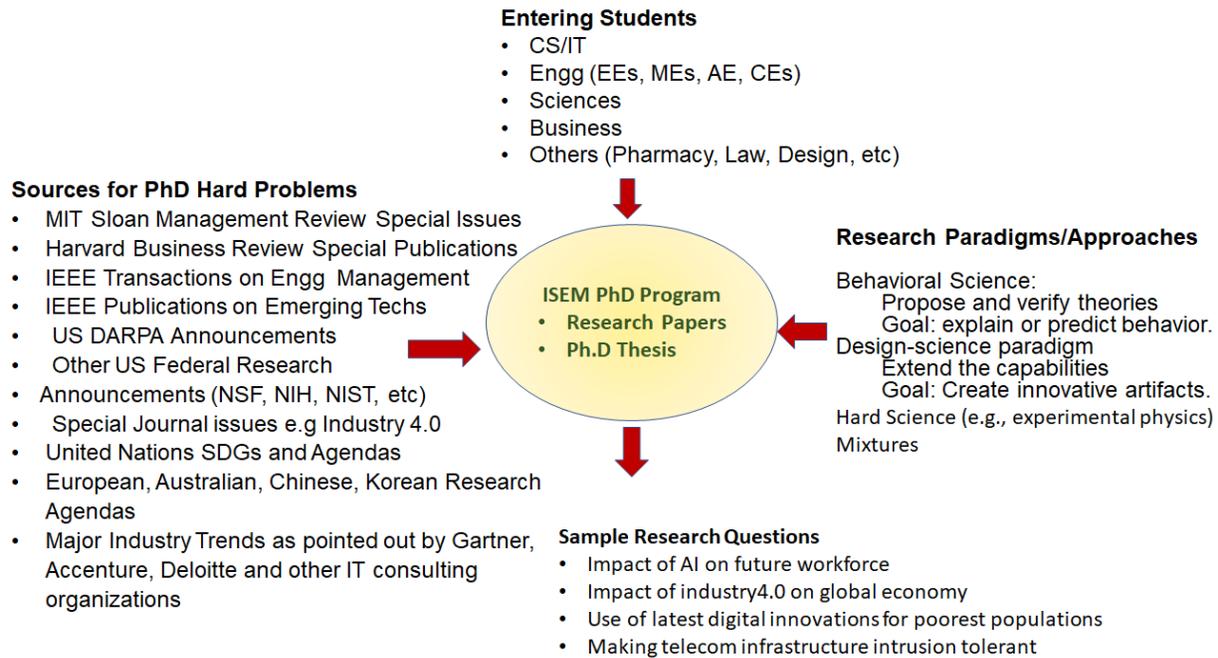- Making telecom infrastructure intrusion tolerant

Figure 3: Overall Structure of Ph.D in ISEM

- The qualified students may come with backgrounds in computer science/IT, engineering, sciences, business and other disciplines such as pharmacy, law and agriculture.
- The students conduct research by using behavioral, design science or mixture of experimental design techniques propose and verify theories and/or create innovative artifacts.
- A wide range of sources, shown in Figure3, are used by the students to select "PhD Hard" problems for their research topics
- Sample research questions may include a wide range of people, processes, and technologies issues facing the next generation of digital enterprises

Figure 4 gives a snapshot of the ISEM Ph.D courses. ISEM PhD students are required to complete six (6) courses from the following upper-level courses – 18 semester hours:

- ISEM 700: Smart Enterprises and Strategic Intelligence
- ISEM 725: Advanced Business Process Modeling and Simulation
- ISEM 730: Advanced Systems Engineering
- ISEM 760: Advances in Operations Management or a 700 level course in Analytics
- MGMT 731: Advances in Entrepreneurship and Innovation or a 700 level course in Analytics
- ISEM 770: Advanced Topics in ISEM

Students then complete six hours in the Doctoral Research Seminar:

- ISEM 780 Doctoral Research SeminarI
- ISEM 781 Doctoral Research SeminarII

Students must also complete the dissertation process by taking 12 semester hours of ISEM 799 Doctoral Studies.
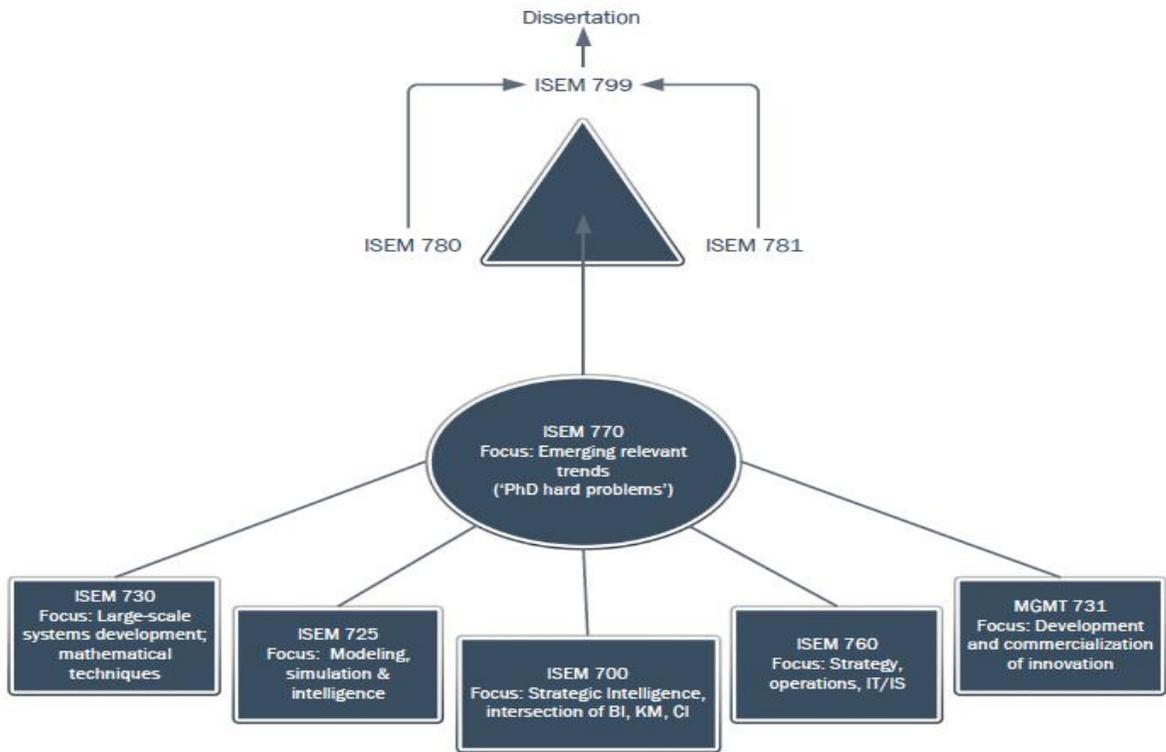
Figure 4: The ISEM Ph.D Courses at a Glance

Exhibit1: MS in ISEM at a Glance

Core Courses for MS in ISEM (15 semester hours)

- ISEM 500: IS Planning, Engg & Mgmt
- MGMT 510: Business Strategy & Management Principles
- ISEM 540: Architecture and Integration of Modern Enterprises
- ISEM 502   User Centered Design or ISEM530 or ISEM565 or CISC510 or LTMS531
- MGMT 511   Digital and Global Enterprises or PMGT510 or ANLY500

ISEM Capstone (6 Semester Hours)

- GRAD 695: Research Methods & Writing
- GRAD699/ISEM 699: Applied Project or Research Thesis

ISEM Elective Courses

Digital Technology Courses

- ISEM 501: Information & Communication Technologies
- ISEM 534: Database Design and Management
- ISEM 536: IT Infrastructure & the Internet
- ISEM 551: Web-based Software Engg
- ISEM555: Mobile Computing and Wireless Communications
- ISEM570: IT Quality Assurance

Business Intelligence (BI) Related Courses

- ISEM 503: Artificial Intelligence Principles and Applications
- ISEM564: Big Data Applications
- ISEM 565: Business Intelligence and Decision Support

ISEM Courses (Cont)

Digital Enterprise Courses

- ISEM 530: Analysis & Design of Information Systems
- ISEM 550: Information Security Management
- ISEM 525: Business Process Modeling and Workflow
- ISEM539: Enterprise Architectures Frameworks
- ISEM 560: eGovernment and eCommerce
- ISEM 568: Aligning Business Strategy with IT Strategy
- ISEM580: ST-Large Scale Systems Engineering

Enterprise Management and Entrepreneurship Courses

- MGMT 512: Marketing in the Digital Age
- MGMT 513: Financial and Managerial Accounting
- MGMT 531: Business Entrepreneurship Principles
- MGMT 532: Business Entrepreneurship Management
- MGMT 533. Business and Entrepreneurial Financing
- ISEM 562: Public Policy

Digital Health and Life Sciences Courses

- ISEM 521: Life Science for IT Professionals
- ISEM 541: Healthcare Systems
- ISEM 542: Health Informatics and Information Systems
- ISEM 543: Digital Health
- ISEM545: Healthcare Data

Electives from Other Graduate Programs
- Analytics Courses
- CISC Courses
- Learning Technologies Courses

Electives from Other Graduate Programs
- PMGT Courses
- Biotechnology Courses
- Healthcare Infomatics Courses

Doctor of Philosophy Course Descriptions (ISEM)

ISEM 700: Smart Enterprises and Strategic Intelligence
Course Prerequisites: Admission to ISEM Doctoral Program

Course Description: Smart Enterprises are the next generation of digital enterprises that heavily rely on artificial intelligence (AI) to deal with customers, suppliers/partners, government agencies and employees. This course highlights advances in research, technologies, systems, and applications as related to intelligent digital enterprises such as smart cities, smart towns, smart healthcare, smart islands, industry4.0, and automated planning environments. The emphasis is on "strategic intelligence" (SI) that refers to the intersection of Business Intelligence, Knowledge Management, and Competitive Intelligence for improving the strategic decision making in Smart Enterprises. Instead of intelligence on one sector, SI concentrates on intelligence that cuts across multiple sectors. The course will use case-based and project-based approaches for discussion and assignments but the focus is on research directions in this broad area of work. Students will be expected to produce a research paper as the final output of this course.

ISEM 725: Advanced Business Process Modelling and Intelligence
Prerequisites: Admission to ISEM Doctoral Program

Description: In-depth coverage of current practical, conceptual, and theoretical techniques of process modeling, simulation, and intelligence. Primary emphasis will be given to understanding and applying various modeling techniques and languages (such as BPEL), types of simulations (such as discrete event simulation), and to using various techniques and tools (such as PROM) to develop data-driven models/prescriptions of process models. All of the foregoing will be considered within the context of the development of solutions to both practical and cutting-edge problems. Students will conduct a focused literature review on some advanced aspect of the studied material and issues.

ISEM 730: Advanced Systems Engineering
Course Prerequisites: Admission to ISEM Doctoral Program

Course Description: This course will introduce students to the discipline of "Large Scale Systems Engineering". Also referred to as "Requirements Driven Development" as well as "Systems Engineering", it represents a disciplined technical and management process by which abstract complex problem descriptions are successfully transformed into fully developed, tested and deployed systems. We will discuss the "art" and "science" of the Large-Scale Systems Engineering discipline. Evolution of Systems Engineering and Advances in Systems Science are discussed. Specialized concepts involved in developing human-engineered complex systems are reinforced primarily through student research and writings. This is a research-focused course that demands extensive student research and academic writing as well as advanced mathematical techniques such as optimization and stochastic processes.

ISEM760 – Advanced Topics in Operations Management
Course Prerequisites: Admission to ISEM Doctoral Program

Course Description: This course discusses how Operations are designed in modern digital organizations and how managers can use Information Technology (IT) to support these operations. Business operations in modern organizations are defined based on business strategies. The main

focus of this course is to learn a) how business strategies are designed and implemented, b) how business operations are defined and managed, and c) how IT is used to enable the business operations. Recent research and industry trends in the field of operations management are discussed in some detail. The course will systematically guide the students to conduct a focused literature review on some advanced aspect of the studied material and produce a research paper. The students will use hands-on tools for practical insights.

MGMT731: Innovation and Entrepreneurship
Prerequisites: Admission to ISEM Doctoral Program

Course Description: In this course, the models for successfully organizing technologically-driven innovations, in entrepreneurial and established firms, are studied, and critiqued. Students learn to develop innovative-based strategies, which will cause entrepreneurial organizations to earn sustained competitive advantage. Students will also discover how to identify, build, and commercialize technological innovations. This course emphasizes the need for continuity in the building and commercialization of valuable innovations. It draws heavily from recent literature and models on entrepreneurial innovation and expects students, not only to critique these existing literature and models, but to design original technology-driven innovations that could aid organizations gain and sustain competitive advantage. The course is divided into 4 Modules, which will take the students from the formulation of innovative ideas to the building of innovative entrepreneurial firms. These modules will systematically guide the students to conduct a focused literature review on some advanced aspect of the studied material and produce a research paper.

ISEM 770: Advanced Topics in ISEM
Prerequisites: Completion of at least 12 semester hours of Upper Level Courses in ISEM PhD Program

Course Description: This course will discuss overall research and industry trends in intelligent digital enterprises, industry4.0, intelligent planning and scheduling systems, next generation of digital infrastructure, business models, systems engineering, and other extant areas of work such as artificial intelligence, big data and analytics. The exact topics discussed will change with time. The main focus will be on guiding the students to emerging relevant trends and to expose the students to a repository of potential "Ph.D hard" questions (i.e., the questions that require Ph.D level research).

ISEM 780: Doctoral Research Seminar I
Prerequisite: Completion of doctoral coursework requirements; pass qualifying examination

Description: This course provides support to doctoral students within their specific domains of research. Led by the faculty advisor for that domain, the course is designed to provide a forum where faculty and students can come together to discuss, support, and share the experiences of working in research. Research topics in the broad area of information systems engineering and management will be discussed. Topic areas may concentrate on industry sectors (e.g., health, education, manufacturing, transportation, energy, environment, agriculture and others), emerging digital technologies and their impacts on the digital enterprises, and/or latest developments in systems engineering principles such as planning, architectures, integration, engineering/re-engineering, and engineering management. Each topic area will be studied in-depth to educate the students in conducting independent research.

ISEM 781: Doctoral Research Seminar II
Prerequisite: ISEM 780 Doctoral Research Seminar I
Description: This seminar is a continuation of ISEM 780 Research Seminar I and provides continued support to doctoral students within their specific domains of research. Led by the faculty advisor for that domain, the course is designed to provide a forum where faculty and students can come together to discuss, support, and share the experiences of working in research.

ISEM 799: Doctoral Studies (Thesis)
Prerequisite: Completion of doctoral coursework requirements; pass qualifying and comprehensive examinations
Description: Advancement to candidacy is a prerequisite of this course. This is an individual study course for doctoral students that culminates in a Ph.D. Thesis. Content to be determined by the student and the student's Doctoral Committee. May be repeated for credit.