



GRADUATE ENGINEERING & GRADUATE SOFTWARE CATALOG

Crystal Conway & Laura DuPont
Assistant Directors of Academic Operations

UNIVERSITY OF ST THOMAS
2115 SUMMIT AVE. ST PAUL. MN 55104

*Please note, due to the nature of these programs the curriculum is subject to change based on the field demand. Any questions regarding discrepancies due to in progress curriculum changes should be directed to the department.

Contents

Introduction	1	Credit by Examination policy for Graduate Courses.....	4
Accreditation	1	New Student Orientation.....	4
MOHE Statement	1	Academic Standards and Policies	4
Notice of Nondiscrimination	1	Advising	4
University of St. Thomas Mission and Vision		Credit Hour Definition	5
Mission	1	Computing Resources	5
Convictions	1	Unacceptable Use	5
Vision	2	Abusing Email	5
School of Engineering Mission, Vision, and Values		Attendance Policy	5
Mission	2	Disability Resources	5
Vision	2	Religious Holidays	5
Values	2	Makeup Exams	6
Graduate Programs in Software Mission, Vision and Values		Transcript Requests	6
Mission	2	Registration Procedures and Policies	6
Vision	3	Registration	6
Values	3	Waitlists	6
Current Institutional Officers.....	3	Holds	7
Board of Governors	3	Add/Drop Classes	7
External Advisory Board	3	Retaking a Course	7
Graduate Programs in Software Strategic Advisory Board	3	Course Load	7
Admission	3	Auditing Policy	7
Requirements and Procedures	3	Graduate Engineering Project Courses	7
International Student Transcript Evaluation....	3	Graduate Software Projects	7
Conditional Acceptance	4	Independent Study Courses	7
Provisional Acceptance	4	Directed Study Courses	8
Transfer Course Credit	4	Financial Obligation	8
Credit by Examination or Experience	4	Tuition, Fees and Related Charges	8
		Semester Dates & Deadlines	8
		Student Account Charges &	
		Payment Options	8

Withdrawal Due to Military Activation	8	Hate Crimes & Bias Motivated Incidents Policy.....	13
Financial Aid Consequences of Withdrawal	8	Tobacco Free Campus Policy	13
Veteran’s Education Benefits	9	Graduate Programs in Software	13
Grades	9	Master’s in Data Science	13
Grade Reports	9	Master’s in Information Technology	14
Calculating a Grade Point Average (GPA)	9	Master’s in Software Engineering	15
Grade Changes	9	Master’s in Software Management	16
Incomplete Grades	9	Graduate Program in Software Certificates	17
Withdrawal from a Class	10	Graduate Certificate in Artificial Intelligence	17
Failing Grades	10	Graduate Certificate in Big Data	17
Academic Probation	10	Graduate Certificate in Business Analysis	18
Degree Requirements	10	Graduate Certificate in Data Analytics	18
Curriculum Catalog of Record	10	Graduate Certificate in Data Management	18
Adding a Second Major or Certificate	10	Graduate Certificate in Embedded Systems	19
Adding a Second Graduate Degree	10	Graduate Certificate in Full Stack Development.....	19
Graduation Requirements	11	Graduate Certificate in Health Analytics	20
Commencement Procedure	11	Graduate Certificate in Digital Transformation	20
Policy on Changes in Rules & Practices	11	Graduate Certificate in Internet of Things	21
University-Wide Graduate Policies.....	11	Graduate Programs in Engineering	21
FERPA	11	Master’s in Electrical Engineering	21
Academic Integrity Policy	11	Master’s in Manufacturing Engineering	24
Violations	11	Master’s in Mechanical Engineering	26
Instructor's Actions	12	Master’s in Regulatory Science	28
Dean’s Actions	12	Master’s in Systems Engineering	29
Possible Sanctions	12	Master’s in Technology Management	30
Student's File	12	Graduate Program in Engineering Certificates	31
Dean's Hearing Committee	12	Graduate Certificate in Manufacturing Systems.....	31
Final Appeal	12		
Sexual Misconduct Policy	12		

Graduate Certificate in Medical Device Development	31
Graduate Certificate in Power Electronics and Systems	32
Graduate Certificate in Technology Leadership	33
Graduate Programs in Engineering Course Catalog	33
Graduate Programs in Software Course Catalog	46

Introduction

The School of Engineering Graduate Student Handbook is designed to help you make the most of your educational experience at the University of St. Thomas. Students are responsible for reading and understanding the policies herein. The contents of this handbook are subject to change without notice and should not be read as part of a contractual relationship.

The University of St. Thomas is an academic community that continually strives for educational excellence. In addition to the academic programs at the School of Engineering, the university offers academic support through the library, writing center, and computer labs. The University of St. Thomas provides many other resources to students including career development, counseling, and health services; recreational and dining facilities; and events such as volunteer programs, lecture series, and religious programs. We encourage you to explore and take advantage of all the university has to offer to increase the quality of your educational experience.

Accreditation

The University of St. Thomas has maintained continuous accreditation by the Higher Learning Commission (HLC) since 1916. HLC is recognized by the U.S. Department of Education as an institutional accreditor. Institutional accreditation by the HLC, provides assurance to prospective students and other constituents that course credits and degrees earned from the institution meet quality standards of higher education. In addition, institutional accreditation assures quality by verifying that an institution is engaged in continuous improvement. HLC evaluates each institution on its academic offerings, governance and administration, mission, finances, and resources.

MOHE Statement

The University of St. Thomas is registered with the Minnesota Office of Higher Education pursuant to sections 136A.61 to 136A.71. Registration is not an endorsement of the institution. Credits earned at the institution may not transfer to all other institutions.

Contact information for the Minnesota Office of Higher Education is:

1450 Energy Park Drive, Suite 350

St. Paul, MN 55108-5227

Phone: (651) 642-0567

Toll Free: (800) 657-3866

Fax: (651) 642-0675

<https://www.ohe.state.mn.us/>

Notice of Nondiscrimination

The University of St. Thomas is an equal opportunity educator and employer. St. Thomas does not unlawfully discriminate, in any of its programs or activities, on the basis of race, color, creed, religion, national origin, sex, sexual orientation, family status, disability, age, marital status, status with regard to public assistance, membership or activity in a local commission, genetic information, or any other characteristic protected by applicable law. The university's policy of nondiscrimination extends to all aspects of its operations, including but not limited to, employment, educational policies, admissions policies, scholarship and loan programs and all other educational programs and activities.

University of St. Thomas Mission and Vision

Mission

Inspired by Catholic intellectual tradition, the University of St. Thomas educates students to be morally responsible leaders who think critically, act wisely, and work skillfully to advance the common good.

Convictions

As a community, we are committed to:

1. pursuit of truth

We value intellectual inquiry as a life-long habit, the unfettered and impartial pursuit of truth in all its forms, the integration of knowledge across disciplines,

and the imaginative and creative exploration of new ideas.

2. academic excellence

We create a culture among faculty, students and staff that recognizes the power of ideas and rewards rigorous thinking.

3. faith and reason

We actively engage Catholic intellectual tradition, which values the fundamental compatibility of faith and reason and fosters meaningful dialogue directed toward the flourishing of human culture.

4. dignity

We respect the dignity of each person and value the unique contributions that each brings to the greater mosaic of the university community.

5. diversity

We strive to create a vibrant diverse community in which, together, we work for a more just and inclusive society.

6. personal attention

We foster a caring culture that supports the well-being of each member.

7. gratitude

We celebrate the achievements of all members of our community in goals attained and obstacles overcome, and in all things give praise to God.

Vision

The University of St. Thomas, a Catholic comprehensive urban university, is known nationally for academic excellence that prepares students for the complexities of the contemporary world. Through disciplinary and interdisciplinary inquiry and deep intercultural understanding, we inspire students to lead, work and serve with the skill and empathy vital to creating a better world.

School of Engineering Mission, Vision and Values

Mission

We provide an applied, values-based learning experience that produces well-rounded, innovative engineers and technology leaders who have the technical skills, passion, and courage to make a difference.

Vision

To be the school of choice for applied engineering and technology leadership education enabling graduates to make a difference to the critical issues of the 21st Century.

Values

- There is an ethical responsibility to improve the quality of life through the comprehensive application of science and engineering.
- A values-based, multi-disciplinary approach to applied science and engineering takes on greater significance as new scientific discoveries and breakthroughs occur.
- An understanding of science and technology is required for competent decision making in business, government, and diplomacy.
- In keeping with the Catholic tradition, we are attentive to the development of the whole person as leader and engineer.

Graduate Programs in Software Mission, Vision, and Values

Mission

Graduate Programs in Software is committed to provide a high-quality graduate education that integrates software technologies into workplace solutions.

Vision

This program strives to enrich the lives of the students and their communities, enhances the economic health of the global economic environment, and supports the overall mission of the University of St. Thomas.

Values

- Provide a learning environment where
- students become aware of the ethical, legal, moral and human issues of the Digital Age.
- Offer quality and professional graduate education for career advancement.
- Respect and practice the advice and counsel of the Strategic Advisory Board regarding industry trends and directions that influence the
- curriculum or programs.

Current Institutional Officers

The School of Engineering's Leadership and Vision can be viewed [here](#).

Board of Governors

The Board of Governors guides the strategic direction of the School of Engineering and assists it in accomplishing its mission. The Board utilizes its influence, both internally within the University and externally, to promote and support the engineering programs at the University of St. Thomas and to enhance the value of the engineering profession as viewed by society. Board membership consists of prominent academic, industry and public sector leaders.

<https://engineering.stthomas.edu/about/leadership-vision/board-governors/index.html>

External Advisory Board

The External Advisory Board (EAB) provides a direct link among students, faculty and

external constituents of the School of Engineering. The Board meets formally three times per year, with each meeting focusing on a major topic: curriculum, student input and review of senior design projects. The Board also includes task groups on specific topics when appropriate.

<https://engineering.stthomas.edu/about/leadership-vision/ext-advisory-board/index.html>

GPS Strategic Advisory Board

The Strategic Advisory Board provides strategic advice and counsel to the Graduate Programs in Software department at the University of St. Thomas. Meeting twice a year, the Board provides current industry trends and directions that impact the curriculum or programs. Using its influence, both internally within the University and externally, the Board promotes and supports the Graduate Programs in Software department (GPS) at the University of St. Thomas. Board membership consists of Senior IT Executives (CIO, VP of IT), Senior R & D Executives (CTO, R & D Directors), consulting companies, and prominent academic leaders.

<https://software.stthomas.edu/about/leadership-vision/advisory-board/index.html>

Admission

Requirements and Procedures

Prospective students should review each program's admission requirements online and apply through the University of St. Thomas's graduate admissions website.

International Students Transcript Evaluation

The University of St. Thomas requires that international transcripts be evaluated by an outside

service such as World Education Services (WES) or Education Credential Evaluators (ECE).

The Office of International Students & Scholars (OISS) provides comprehensive immigration and support services to international students and scholars while supporting them in pursuit of their educational, personal and professional goals, and to promote their full functioning in the U.S. and integration into the University of St. Thomas. The Office of International Students & Scholars can be reached by phone at 651-965-6650.

Conditional Acceptance

Applicants who have one or more admission requirements in progress (e.g., completing English proficiency or a pending undergraduate degree) may be conditionally admitted. If the applicant does not meet the conditions of acceptance, the offer of admission will be rescinded.

Provisional Acceptance

Some applicants who do not meet the basic admission criteria may be accepted provisionally into a degree program. These students will remain on provisional status until they have met the conditions of the acceptance.

Transfer Course Credit

Only courses from regionally accredited U.S. institutions are eligible for transfer credit. In addition, the course must have been completed with a grade of "B-" or better, must be applicable to a graduate degree at the prior institution, and must be equivalent to a University of St. Thomas course required or permitted for meeting program requirements. The School of Engineering will certify equivalency. A maximum of two (2) courses or six (6) credits will be considered for transfer.

Credit by Examination or Experience

This program does not grant credit for competencies gained prior to matriculation at the university. If a student believes they are already proficient in the

material taught in a required course, they can contact their advisor to discuss alternatives.

Credit by Examination policy for Graduate Courses

The School of Engineering may grant credit by examination for department approved professional development offerings taught by St. Thomas faculty (or in collaboration with an external organization).

- 1) Courses in the School of Engineering Graduate Catalog that are delivered through a professional development offering are available for credit by examination.
- 2) To receive credit, student should receive a passing score equivalent to a grade of C on the examination.
- 3) Maximum of 15 credits will be accepted to be used towards a MS degree. The student will be required to take a minimum of 21 additional credits to complete the MS degree.

New Student Orientation

All students are encouraged to attend the New Student Orientation prior to registering for and attending classes.

New Student Orientation is held prior to the first day of each semester. If a student is unable to attend the Orientation, it is the student's responsibility to contact the School of Engineering Graduate Student Services Office (651-962-5500) prior to the start of classes for the semester to obtain detailed information.

Academic standards and policies

Advising

Students can find their assigned advisor by visiting Murphy Online.

Advisors are available by appointment or during drop-in office hours to discuss in depth academic planning, course selection and degree requirements.

Credit Hour Definition

In accordance with University policy, a credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that reasonably approximates:

- one hour (50 minutes) of classroom or faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester of credit, or the equivalent amount of work over a different amount of time; or
- at least an equivalent amount of work as required in paragraph (1) of this definition for other activities as established by the institution, including laboratory work, internships, practica, and other academic work leading toward the award of credit hours.

Computing Resources

It is expected that students will use the University of St. Thomas computing resources responsibly and professionally, for academic purposes only. The School of Engineering Graduate Programs utilizes email account as its main mode of communication with students. Therefore, graduate students are responsible for all information sent to their St. Thomas email account.

Unacceptable Use

Conduct which constitutes unacceptable use under this Policy includes, but is not limited to:

Using university systems or content (including subscribed library electronic databases) for personal gain, for commercial purposes or for partisan political purposes: for example, selling access to a university user ID or to university systems or networks; performing work for profit with university

resources in a manner not authorized by the university; or using electronic mail to circulate advertising for products.

Abusing Email

The following activities specific to email use are prohibited:

Initiating or facilitating in any way mass electronic mailing (e.g. “spamming”, “flooding” or “bombing”) except for purposes of conducting university business, and then only with the advice and consent of Information Technology Services (ITS) regarding when and how to send the email.

Attendance Policy

Regular class attendance is expected. Failure to attend class can impact your grade for the course. Instructors determine the specific attendance policies for their course(s) and that information is typically found in the course syllabus. Questions about the attendance policy for a course should be directed to the instructor of the course.

If a student must miss class, it is the student’s responsibility to notify the instructor before the class, to meet all assignment deadlines, and complete any makeup work. Students may only miss two classes per course during a semester. If a student’s circumstances necessitate missing class repeatedly, the student will need to consult with the instructor to determine if it is feasible to remain enrolled in the course.

Disability Resources

Classroom accommodations will be provided for qualified students with documented disabilities. For details, visit Disability Resources.

Religious Holidays

Consistent with our commitment of creating an academic community that is respectful of and welcoming to persons of differing backgrounds, we believe that every reasonable effort should be made to allow members of the university community to

observe their religious holidays without jeopardizing the fulfillment of their academic obligations.

Students should not be penalized for class absences because of religious holidays and, therefore, should notify the faculty member of conflicts due to religious holidays well in advance of any anticipated absence. If asked, the student should provide accurate information about the obligations entailed in the observance of that particular holiday.

Makeup Exams

Attendance at all examinations is required. If a student must miss class during a scheduled exam due to an emergency or unavoidable conflict, the student should request a makeup exam from the instructor as soon as possible. The makeup exam request must include the reason for the absence.

Whether or not the request is granted is entirely at the discretion of the instructor. If the instructor allows the makeup exam, arrangements must be made with the School of Engineering Graduate Student Services office to take the exam during regular business hours.

Transcript Requests

The Office of Student Data & Registrar maintains the integrity of student records and helps ensure students understand the policies and procedures governing participation in academic coursework at the University of St. Thomas.

New Graduates: Transcripts will reflect your degree award date approximately three weeks after the end of the term.

All St. Thomas students (alumni and current students) may order an official transcript through the Parchment St. Thomas Online Storefront.

- Alumni without access to Murphy Online must order transcripts through Parchment or in-person by submitting the required Transcript Request Form to the Office of Student Data and Registrar.

- Current students have those same options,
- but may also request a transcript using Murphy Online.

Students may order either an electronic or paper transcript online. Paper transcripts are available for in-office pickup or can be mailed to the student or an institution designated by the student.

For more information, please visit the Office of Student Data & Registrar.

Registration procedures and policies

Registration

Registration is based on the number of credits remaining in a student's program. To find out when you are eligible to register, log in to Murphy Online and click on the "Student Services" tab followed by "Registration".

Returning students who have not taken a class for more than one year must reactivate their student record before registering. Please contact the appropriate program to complete this action.

ENGR: gradengineering@stthomas.edu

GPS: gradsoftware@stthomas.edu

Waitlist Policy

During the term registration period, students have the option of adding their name to a course waitlist in Murphy Online. When a seat becomes available, the student will be notified via their St. Thomas email account. Students have 72 hours to log into Murphy Online and register for the course. If a student does not act within the 72 hours, their name will be removed from the waitlist. Approximately two weeks before the start of the term, students have 24 hours to log into Murphy Online and register for the course. If a student does not act within the 24 hours, their name will be removed from the waitlist. Once the term begins, waitlists no longer exist.

Holds

Students may check for registration holds via Murphy Online. If a student has a hold they wish to discuss, please contact the office that placed the hold.

Delinquent financial accounts must be cleared with the Business Office (651-962-6600) prior to student registration.

Add/Drop Courses

Students may add courses via Murphy Online until the first day of the term. Students may drop courses via Murphy Online through the "DROP" period, which is generally through the first week of class. Exact add and drop deadlines for tuition refunds are posted on the School of Engineering website.

Retaking a Course

Students who fail a REQUIRED course, must retake the course and receive a minimum passing grade of C-. The passing grade will replace the failed grade and is applied to the student's GPA. Both grades will appear on the student's transcript. Students who fail an ELECTIVE course have the option of retaking the class. If a student does not retake the failed elective course, the failing grade is applied toward their institutional GPA which is posted on the transcript.

Course Load

It is recommended that a student working full-time enroll in no more than two courses during spring and fall semester, and one course during summer session.

Students may not register for more than six (6) credits or two (2) courses during any semester without first obtaining permission from their advisor.

Auditing Policy

A student may choose to audit a course rather than take it for credit. If attendance is satisfactory, the course number, title and the audit designation will appear on the transcript. If attendance is not satisfactory, the course will not appear on the transcript. In no case may a student receive credit for

a course that was audited unless the course is retaken for credit. Students may audit courses provided space is available after degree-seeking students have had first priority to register. Permission to audit a course must be obtained from the Associate Dean. A student may not designate audit status after the last day to withdraw with a "W."

Auditor status cannot be changed to "for credit" status after the ADD period has expired. The fee to audit is 66% of full course tuition. Enrolled students who opt to audit a course after the DROP period will not receive a refund for the difference between tuition and the audit fee.

Graduate Engineering Project

These courses are built around a student-originated project that is limited in content and time frame. They provide an opportunity for students to receive individual instruction and guidance while pursuing a subject of special interest. A project course requires a learning contract signed by the student and instructor. This contract must be submitted to the School of Engineering Graduate Student Services office prior to registration for the course.

Graduate Software Project Course

Students interested in taking a project course in Graduate Software must submit a Course Proposal to their course instructor. The course instructor and the Associate Dean must approve the project prior to registration for the course.

Independent Study Courses

Students can only request an independent study course when regular course offerings do not cover the material proposed in the study. In other words, what is proposed for an independent study would be in addition to the material covered by the regular course. Additional material must be related to the course material.

An independent study course requires a learning contract signed by the student and instructor with

approval from the Associate Dean of Graduate Programs in Engineering & Software.

Directed Study Courses

Directed Study courses are comprised of a regular School of Engineering course delivered by means of directed study. The provision of directed study courses will be arranged by the Associate Dean of Graduate Programs in Engineering & Software under exceptional circumstances.

Financial Obligation

At the University of St. Thomas, payment of tuition and all other fees becomes the obligation of the student at the time of registration. Prior to online registration, students will be prompted to electronically complete a payment agreement document.

Tuition, Fees and Related Charges

A complete list of Tuition, fees and related charges can be found [here](#).

Semester Dates and Deadlines

A complete list of semester dates, deadlines, observed holidays and our refund schedule can be found [here](#).

Student Account Charges and Payment Options

“Tuition, fees, and other charges for the academic term are billed at the outset of each term. Students are responsible for timely paying all amounts due to St. Thomas. Charges are made to each student’s account established at the time of registration, in accordance with the [Student Payment Agreement and Disclosure Statement](#).

Students may pay their charges in a single lump sum by the first due date after the charges are billed, or they may pay their charges over a longer time period, in accordance with one of two [Payment Plan](#) options:

- The Extended Payment Plan is available to all students and allows students to pay charges for the fall, spring, and summer academic terms in installments. All charges must be fully paid before the end of the applicable term. Until the charges are fully paid, students will not be permitted to enroll in a subsequent academic term.
- The End of Term Payment Plan is available to students who do not receive financial aid from any source other than their employer, and who are eligible for an employer tuition reimbursement of at least 50% of the tuition balance based on receipt of a satisfactory grade report for the corresponding term. Under this plan, no tuition payment is required until after the end of the term, when grade reports have been issued. If the charges are not timely paid, students will not be permitted to enroll in a subsequent academic term.

Under the payment plans, monthly finance charges will be assessed on the unpaid balance in the student account.

Contact the [Business Office](#) for additional information about payment options.”

Withdrawal Due to Military Activation

Graduate students who are called to active duty in the armed services will be granted a 100% tuition adjustment for the semester in which they were deployed regardless of the date they were activated. To receive this tuition adjustment, the student must present the School of Engineering Graduate Student Services office with a copy of their deployment orders.

Financial Aid Consequences of Withdrawal

Financial aid recipients who withdraw from the University of St. Thomas should be aware that they might need to return part or all of the funds they were awarded. Before officially withdrawing from classes,

students should contact the Graduate Financial Aid Office to inquire about their specific situation.

Veteran's Education Benefits

All Veteran's Education Benefit programs are handled by the Veterans School Certifying Official in the Office of Student Data and Registrar.

The Veteran Resource Center provides military-veteran students with an organization to call their own that will allow them to meet and network with one another through club events, meetings and community services in a professional manner while simultaneously providing a link for the University of St. Thomas community to gain insight into the experiences, needs, and desires of today's military-veteran student. Please visit the Veterans Resource Center for additional information.

Grades

Grade Reports

Final grades are posted and available through Murphy Online.

Calculating a Grade Point Average (GPA)

Grade points are determined on the following basis:

Grade	Quality Points	Grade	Quality Points
A	4.0	C+	2.3
A-	3.7	C	2.0
B+	3.3	C-	1.7
B	3.0	F	0.0
B-	2.7		

The grades listed below are not assigned quality points and are not calculated in the GPA.

- S - Satisfactory
- I - Incomplete
- W - Withdrawal
- R - Registered, no credit

- AU - Audit, no credit
- IP - In Progress
- NR - Not Reported

Grade points for a course are computed by multiplying the quality point value of the letter grade by the credit value of the course. Grade point average (GPA) is calculated by dividing the sum of grade points earned for all courses by the total number of credits attempted.

Grade Changes

Instructors may complete a grade change form if there has been an error in the computation, transcription, or reporting of the grade. Grade changes may not be made based on additional work completed after the grade deadline for the term. All grade change forms must be reported to the School of Engineering Graduate Student Services office. After one year, grade changes must be reviewed and approved by Dean or Dean's designee.

Incomplete Grades

A student who has completed at least 80% of the required coursework, but due to unforeseen and unavoidable circumstances (e.g., illness or emergency) is unable to finish the course within the semester for which they were registered, may petition the instructor for an Incomplete. The request must be made prior to the grade deadline for the term. If granted, a grade of "I" will be entered for the course. The grade of "I" is not to be used to grant extra time for a student to resubmit work or complete extra credit assignments in order to improve the grade. Students who receive an "I" are advised that they must complete coursework by June 1 for the fall semester and the January term, and by January 1 for spring semester and summer terms. If the course requirements are not met by the deadline, the incomplete grade becomes a grade of "F". There are no exceptions to these deadlines.

Withdrawal from a Course

The mark of “W” is assigned to a course from which a student withdraws after the tenth day of the Fall & Spring semesters. For summer session and January term the time frame is shorter. A grade of “F” will appear on the transcript for students withdrawing after this deadline.

Failing Grades

Students who receive a failing grade, “F,” for any required course must retake and successfully complete that course to receive credit toward program requirements. When the course has been repeated, only the passing grade will be computed into the cumulative grade point average. The “F” will remain on the transcript.

Academic Probation

While a grade of “C” is considered minimally satisfactory performance, multiple “C” grades are regarded as unsatisfactory academic progress within the program as a whole. Any student who have completed six or more credits and whose cumulative GPA is less than 2.7 will be placed on academic probation and a registration hold will be placed on the student’s record.

When a student is on academic probation, they must meet with the Associate Dean prior to registering for any future course(s).

If the student fails to receive a grade of “B” or better while on probation, the student will be academically suspended for one semester. Upon the student’s return, they will again be placed on academic probation. Failure to obtain a “B” or better in the next course will result in dismissal from the program.

Once the cumulative GPA is above 2.7, academic probation status will be removed. However, if the cumulative GPA drops below 2.7 again, the student’s status will return to academic probation.

Students may appeal a suspension or dismissal. Appeals must be directed to the School of Engineering

Associate Dean. If students are readmitted on appeal, the program may impose conditions on the readmission.

Degree Requirements

Curriculum Catalog of Record

Catalogs for the School of Engineering Graduate Programs are posted on the website. The catalog in effect at the time of matriculation is the student’s catalog of record and determines the student’s graduation requirements. If a revision to the catalog is released, currently enrolled students may request to switch to the newer version to take advantage of revised program requirements. Students must fulfill all requirements in the curriculum catalog they have chosen; they may not combine requirements from multiple versions.

Students must contact the School of Engineering Graduate Student Services office if they wish to change their catalog of record.

Adding a Second Major or Certificate

Students have the option to add a second program (major). If a second program is added, both programs are required to be completed before the master’s degree is awarded.

Students may add one certificate to their degree program. The certificate is required to be completed before or at the time the degree requirements are met. If the certificate requirements are met prior to the degree requirements, the certificate will be awarded in the term of completion.

Adding a Second Graduate Degree

Individuals may apply to complete a second graduate degree in a different discipline. The requirements for the additional degree must include at least 24 non-duplicated graduate credits and must meet all requirements of the program’s accrediting body.

Previously completed graduate credits older than 8 years may not be applied toward meeting requirements for the additional degree.

Graduation Requirements

The minimum requirements to receive a master's degree from a Graduate Program in the School of Engineering include:

- Students must complete all degree requirements from their catalog of record
- All substitutions of required courses must be approved in advance of taking the course.
- Student must have a cumulative GPA of at least 2.7.
- Credits earned more than 10 years prior to graduation cannot be used to meet the requirements of a degree.

Students graduate at the end of the semester in which they complete their degree requirements.

Commencement Procedure

Commencement ceremony is held every Spring in May. For current information please visit the Commencement webpage for additional information.

Policy on Changes in Rules and Practices for School of Engineering Programs

The University of St. Thomas reserves the right to change any rule or practice pertaining to any aspect of its operation, including graduation requirements, grading, and academic standing requirements. It is possible that rules or practices described in School of Engineering publications have been changed since they were published. Please contact Graduate Student Services for up-to-date information on the rules and practices.

University-Wide Graduate Policies In addition to department policies, university-wide graduate policies can be found [here](#).

FERPA

The Family Educational Rights & Privacy Act (FERPA) affords students certain rights with respect to their education records. For questions regarding FERPA, please contact the Office of Student Data & Registrar directly.

Academic Integrity Policy

Honesty and trust among students and between students and faculty are essential for a strong, functioning academic community. Students are expected to do their own work on all academic assignments, tests, projects and papers. Academic dishonesty will not be tolerated at the University of St. Thomas. Students are encouraged to report incidents of academic dishonesty to course instructors or the Associate Dean.

Violations

Common forms of academic dishonesty include, but are not limited to, the following:

- Cheating: Using, accessing, or trying to use unauthorized materials, information, or study aids in any academic work submitted for credit; giving or receiving unauthorized materials or aid in an academic exercise.
- Fabricating or misrepresenting: Falsifying or inventing any information or citation in an academic exercise; fabricating or misrepresenting a reason for an absence or missed deadline; submitting academic work completed largely in one class to satisfy an assignment in a second class without instructor permission; fabricating or tampering with academic records.
- Facilitating Academic Dishonesty: Knowingly helping or attempting to help another student commit academic dishonesty.
- Plagiarizing: Claiming or submitting the ideas, words, or statements of another person as one's own without proper citation regardless

of intent to deceive. Even inadvertent plagiarism is a serious matter; students must familiarize themselves with citation standards. The University of St. Thomas Library and the Center for Writing both have resources available to assist with proper citation. For more information, visit:
http://libguides.stthomas.edu/citing_sources
<https://www.stthomas.edu/writing/resource/sforstudensts/>.

When academic dishonesty occurs, the following procedures will be followed:

Instructor's Actions

When an incident of academic dishonesty is discovered, the instructor will notify the student and, if possible, meet to discuss the evidence and penalties. The instructor must also inform the Associate Dean or Dean of the School of Engineering by providing a summary of the nature of the offense, any supporting evidence and any information regarding the student's response to the incident. The minimum penalty for academic dishonesty is a failing grade for the work involved. The instructor may request additional penalties. The student has a right to appeal the determination of the instructor to the Associate Dean or Dean.

Dean's Actions

Upon receipt of the communication from the instructor, the Dean or the Dean's designee, will review the offense, consult the student's file for previous offenses and make a determination about the case and the penalties. The Dean may consult with the Office of the Dean of Students. If no further action is deemed necessary, the instructor's sanction will stand and the Dean will send documentation of the offense to the Office of Student Data and Registrar for inclusion in the student's file. If further penalties are to be imposed, the Dean will notify the student and arrange to meet to discuss the matter. The Dean has the authority to impose sanctions beyond those recommended by the instructor.

Possible Sanctions

Among the sanctions considered by the Dean will be the following: failure for the course in which the incident occurred; suspension from the University for the following semester; expulsion from the University; revocation of a conferred degree; community service; or other appropriate measures as agreed upon in consultation with the student.

The materials relating to the incident, including the instructor's correspondences with the student and the Dean and the Dean's decision following review will become part of the student's academic history file. A summary of the incident may also be sent to the Office of the Dean of Students.

Dean's Hearing Committee

If the nature of the offense is severe or if the student has been involved in a previous incident of academic dishonesty, the Dean may convene a hearing. The hearing body should include representative faculty who review the case and provide a recommendation to the Dean. The hearing may include direct questioning of both the student and the faculty member.

Final Appeal

Following the review and final decision by the Dean, the student may appeal the Dean's decision in writing to the Executive Vice President for Academic Affairs.

Sexual Misconduct Policy

The University of St. Thomas mission and convictions embody the University's commitment to promote and protect the personal dignity and well-being of every member of the St. Thomas community. Sexual harassment, sexual assault and other forms of sexual misconduct are antithetical to that commitment. Moreover, they constitute unlawful sex discrimination. All forms of sexual misconduct are prohibited by St. Thomas.

The St. Thomas mission and convictions also embody the University's strong commitment to academic

freedom, rigorous thinking and the free and full pursuit of knowledge and truth by every member of the St.

Thomas community. The prohibition on sexual misconduct is critical to and consistent with these commitments. St. Thomas cannot achieve its educational objectives in an environment in which sexual harassment or other forms of sexual misconduct are tolerated.

This policy defines the forms of sexual misconduct prohibited by the University, describes reporting options, and identifies the procedures the University will use to resolve reports of sexual misconduct. This policy reflects the University's commitment to: (1) fostering an environment where sexual misconduct is not tolerated and where all members of the community are well-informed and supported in reporting sexual misconduct, and (2) resolving reports of sexual misconduct in a prompt, impartial and equitable manner.

Please visit the university's Title IX webpage for additional information regarding Sexual Misconduct policy and procedures.

Hate Crimes and Bias Motivated Incidents Policy

The University of St. Thomas continually strives to meet the highest standards of respect and civility that are both implicit and explicit in its vision, mission and convictions. It is the university's goal that no member of the University community shall be subject to any physical or verbal harassment, abuse or violence based on the individual's race, color, gender, sexual orientation, age, national origin, religion or physical or mental disability.

The value placed upon human dignity and diversity should be interpreted as augmenting, not infringing upon "freedom of expression" or "academic freedom." As a result, the university has adopted a policy that is designed to investigate and resolve such claims in a direct and thorough manner while respecting the rights of all parties involved.

Please contact the Dean of Students office with questions regarding Bias and/or Hate Motivated Incident reporting procedures.

Tobacco Free Campus Policy

Consistent with the University of St. Thomas conviction to support the well-being of each member of our community, the University is committed to maintaining a tobacco-free campus. This commitment includes providing a healthy campus for all campus members and visitors.

The Tobacco-Free Campus Policy establishes a tobacco-free environment on all University owned or leased properties in St. Paul and Minneapolis. Consequently, the use, distribution or sale of tobacco, including any smoking device or carrying of any lighted smoking instrument, in University buildings or on University premises, or in University-owned, rented or leased vehicles, is prohibited.

For the full Tobacco Free Campus policy, please visit: <https://www.stthomas.edu/media/officeofgeneralcounsel/policies/111Tobacco-FreeandSmoke-FreeCampusPolicy.pdf>.

School of Engineering Course Catalog

Graduate Programs in Software

Master's in Data Science

The M.S. degree in Data Science prepares students to pursue careers in the emerging and high-growth fields of data science and big data. It combines in-depth understanding with hands-on skills, technologies, techniques, and analysis tools for data science.

Graduates of this program will have the theoretical, practical, and comprehensive knowledge to manage and analyze large-scale, complex data to enable efficient data-driven discoveries and decisions.

To complete the requirements for the Master of Science in Data Science, students must successfully

complete 12 courses (36 graduate semester credits) and maintain a GPA of 2.7.

Choose one elective (or two electives if SEIS 603 is waived) from any course listed in the Graduate Programs in Software course catalog.

Current and inactive students who enrolled in this program prior to fall 2018 may opt to remain with the graduate program requirements from their current catalog or move forward to the newest graduate program requirements for the M.S. Degree in Data Science.

Transfer courses: Students may request a transfer of up to two graduate courses (six semester credits) from their previously attended, regionally accredited institution(s) towards their GPS Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses:

- SEIS 603 Foundations of Software SEIS 610 Software Engineering
- SEIS 615 DevOps and Cloud Infrastructure
- SEIS 630 Database Management Systems and Design SEIS 631 Foundations of Data Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 732 Data Warehousing and Business Intelligence SEIS 736 Big Data Architecture
- SEIS 737 Big Data Management SEIS 763 Machine Learning SEIS 764 Artificial Intelligence
- Elective Courses
- Choose one elective (or two electives if SEIS 603 is waived)

Master's in Information Technology

The M.S. degree in Information Technology provides students with relevant, practical, and applicable knowledge in Information Technology (IT) and Information Systems (IS). This program provides students with the appropriate mix of technical, professional, and business skills. Graduates of this program will be equipped to bridge the gap between roles in software development/management and software technology infrastructure.

The M.S. degree in Information Technology (IT) prepares individuals to develop and support organizational IT infrastructure.

The goal of an IT organization is to meet business needs by creating and implementing a hardware/software plan including a vision and strategy for upgrades and maintenance. IT aggregates business and technology needs from across the company (as broad as catalog data bases, e-commerce functions for online order processing, integration with fulfillment components, and customer relationship management, in addition to traditional accounting, bookkeeping, and audit functions).

IT then organizes these needs into an enterprise-wide resource plan to 1) fulfill the business processes in a global, electronic commerce, 24/7 environment, 2) safeguard critical and proprietary data, 3) assure disaster-recovery plans, and 4) migrate to new platforms as they become available.

Because this program focuses both on IT and IS issues, graduates of this program can apply the acquired skills and knowledge to advance their careers in IT architecture, strategic software business analysis planning, project portfolio and program management jobs. It can also advance more experienced IT professionals and project managers to pursue technical leadership roles.

To complete the requirements for the Master of Science with a major in information technology, students must successfully complete 12 courses (36

graduate semester credits) and with a GPA of at least 2.7.

Students must complete 9 required technical courses from Graduate Programs in Software (GPS) and 3 elective courses from the GPS graduate course curriculum.

Current and inactive students who enrolled in this program prior to fall 2018 may opt to remain with the graduate program requirements from their current catalog or move forward to the newest graduate program requirements for the M.S. Degree in Information Technology.

Complete a total of 12 three-credit courses (36 graduate credits).

Electives:

Choose two electives (or three electives if SEIS 603 is waived) from the Graduate Programs in Software (SEIS) course catalog.

Transfer courses: Students may request a transfer of up to two graduate courses (six semester credits) from their previously attended, regionally accredited institution(s) towards their GPS Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses:

- 603 Foundations of Python I
- 604 Foundations of Python II
- 610 Software Engineering
- 632 Data Analytics & Visualization
- 615 Cloud Computing
- 616 Infrastructure as Code
- 630 Database Management Systems & Design
- 663 IT Infrastructure Management

- 2 SEIS electives

Master's in Software Engineering

Scientific, technical and sophisticated commercial systems developers require education in what has come to be called "software engineering," which encompasses the utilization of sophisticated development tools. This domain focuses on technique-oriented computer science, computational systems software development, and applied research. It emphasizes the quantitative and scientific characteristics in software development. Hardware/software issues, embedded control in hardware, and large software/hardware systems development are all part of this emphasis.

This program would be of interest to persons in computer science, computational science, systems software development, knowledge-based systems, database development, distributed database development, telecommunications, networking, multimedia software development, and neural networks. Students completing this degree almost always will be working in organizations where the MS is the recognized degree, and where most of their colleagues will also hold an MS degree in engineering or a scientific discipline.

To complete the requirements for the Master of Science in software engineering (MS) students must successfully complete 12 courses (36 graduate semester credits) and maintain a GPA of 2.7.

Current and inactive students who are enrolled in this program prior to fall 2018 may opt to remain with the graduate program requirements from their current catalog or move forward to the newest graduate program requirements for the M.S. degree in Software Engineering.

Choose 5 electives (6 if SEIS 601 is waived) from the SEIS course list. A maximum of two graduate-level courses may be non-technical.

A student may take up to 4 courses (12 semester credits) of graduate non-SEIS courses (including transfer courses) as a part of the MS program. All such

courses must be approved as "technical" by the Associate Dean. Transfer courses: Students may request a transfer of up to two graduate courses (six semester credits) from their previously attended, regionally accredited institution(s) towards their GPS Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses:

- 601 Foundations of Java I
- 602 Foundations of Java II
- 610 Software Engineering
- 615 Cloud Computing
- 627 Software Planning and Delivery Management
- 630 Database Management Systems & Design
- 622 Web App Development
- 739 Software Analysis, Design, and Implementation
- 2 SEIS electives

Master's in Software Management

No longer enrolling for program effective Fall 2022

This program provides students with the most relevant, practical, and applicable knowledge available in software engineering and software management. With the appropriate mix of technical and business skills, graduates of this program can systematically analyze business situations and propose, plan, and manage rigorous software development strategies and efforts to fulfill organizational objectives.

Since this program focuses on both technical and development management issues, graduates of this

program can apply the acquired skills and knowledge to advance their careers in software architecture, strategic software business planning, and project portfolio and program management jobs. It can also advance more experienced software engineers and project managers to pursue technical leadership roles in the modern software business.

To complete the requirements for the Master of Science with a major in software management, students must successfully complete 36 graduate semester credits and maintain a GPA of at least 2.7. Students must complete 8 SEIS courses (24 graduate semester credits) from the Graduate Programs in Software curriculum, and 4 elective courses (12 graduate semester credits).

Current and inactive students who are enrolled in this program prior to Fall 2018 may opt to remain with the graduate program requirements from their current catalog or move forward to the newest graduate program requirements for the M.S. in Software Management.

Transfer courses: Students may request a transfer of up to two graduate courses (six semester credits) from their previously attended, regionally accredited institution(s) towards their GPS Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited. For more information on transfer courses, please see 'Transfer Courses' listed under Academic Policies and Procedures.

Required Courses:

- SEIS 603 Foundations of Software Development - Python (waived for appropriate prior programming experience)
- SEIS 605 Technical Communications SEIS 610 Software Engineering
- SEIS 615 DevOps and Cloud Infrastructure SEIS 627 Software Planning and Testing
- SEIS 630 Database Management Systems and

Design

- SEIS 663 Information Technology Security and Networking SEIS 709 Enterprise Architecture and Strategy
- Elective Courses:
- Choose two SEIS electives Choose two OCB electives

Graduate Programs in Software Certificates

The University of St. Thomas Graduate Programs in Software graduate-level certificates are designed for working professionals to advance your knowledge in a specialized area, helping to give you an advantage in your career.

In only four or five classes you will have a graduate certificate from the University of St. Thomas to add to your resume. Most graduate certificates can be completed in about a year, depending how many courses you choose to take in a semester. Moreover, you may use your credits

earned in obtaining your certificate to continue on and earn your master's degree with as few

as eight additional classes.

We offer the following graduate certificates:

Graduate Certificate in Artificial Intelligence

The Graduate Certificate in Artificial Intelligence is aimed at preparing professionals who need to handle the growing demands in analyzing digital information for predicting, visualizing, and implementing cutting-edge AI techniques such as artificial neural networks and deep learning.

Students have the option to use the coursework from the Graduate Certificate in Artificial Intelligence to continue in a Master of Science degree program offered through the Graduate Programs in Software.

Required Courses:

Students will be expected to have a prior background in Python or take SEIS 603

- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence

Graduate Certificate in Big Data

This program was created in response to the growing demand for professionals who have the analytic skills and ability to understand and manage massive data sets that organizations continue to capture, store, search, share, visualize and analyze across all sectors (private, public, government, and academic).

Students have the option to use the coursework from the Graduate Certificate in Big Data to continue in a Master of Science degree program offered through the Graduate Programs in Software.

Organizations need to manage Big Data as they continue to capture, store, search, share, visualize and analyze massive, unstructured, and complicated data sets. In response to the growing demand to manage Big Data across all sectors (private, public, government and academic), the GPS department has created the Graduate Certificate in Big Data. This certificate will allow professionals to understand these massive datasets by having the analytics skills needed to work in this high demand field.

To complete the Graduate Certificate in Big Data, the student must complete five required SEIS graduate courses (12 graduate semester credits) with at a GPA of 2.7 or better.

Required Courses:

Students will be expected to have a prior background in Python or take SEIS 603

- SEIS 630 Database Management Systems and Design

- SEIS 631 Data Preparation and Analysis
- SEIS 732 Data Warehousing and Business Intelligence or SEIS736 Big Data Engineering
- SEIS 737 Big Data Management

Graduate Certificate in Business Analysis

Designed for professionals seeking to advance their career or planning a career change as business analysts, systems analysts, project analysts, project managers, software engineers, or quality assurance analysts. A key facilitator within any organization, the business analyst works as a liaison among stakeholders in order to elicit, analyze, communicate, and validate requirements for changes to business processes, policies, and information systems. The Graduate Certificate in Business Analysis program focuses on both the technical and managerial aspects of software development that are required knowledge for successful business analysts, systems analysts, project analysts, project managers, software engineers, or quality assurance analysts.

To complete the Graduate Certificate in Business Analysis, the student must complete the four required SEIS graduate courses (15 graduate semester credits) with a GPA of 2.7 or better.

Required Courses:

- SEIS 601 Foundations of Java I or SEIS603 Foundations of Python I
- SEIS 610 Software Engineering
- SEIS 630 Database Management Systems and Design
- SEIS 627 Software Planning and Delivery Management

Graduate Certificate in Data Analytics

Data analytics involves using tools and techniques to turn raw data into insights that

help companies and organizations make better business decisions. The graduate certificate in data analytics uses industry-standard software in practical applications directly related to current trends and issues that impact organizations across a broad spectrum. Students will gain hands-on experience with a variety of analytical tools and learn how to manage and manipulate data, create data visualizations, and make strategic data-driven recommendations to influence business outcomes.

Students have the option to use the coursework from their graduate certificate to continue in a Master of Science degree program offered by Graduate Programs in Software.

Required Courses:

- SEIS 603 Foundations of Python I
- SEIS 630 Database Management Systems and Design
- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization

Graduate Certificate in Data Management

No longer enrolling for program effective Fall 2022

This certificate program provides students with essential data management skills in the areas of data modeling and specification, data model quality management, database development, database administration, and data warehousing.

Data management covers the development, execution, and supervision of plans, policies, programs and practices that control, protect, deliver and enhance the value of data and information assets. The Certificate in Data Management addresses this growing market.

This certificate program provides students with essential data management skills in the areas of data

modeling and specification, data model quality management, database development, database administration, and data warehousing.

To complete the Graduate Certificate in Data Management, the student must complete five required SEIS graduate courses (15 graduate semester credits) with at a GPA of 2.7 or better.

Current and inactive students who enrolled in this program prior to fall 2018 may opt to remain with the graduate program requirements from their current catalog, or move forward to the newest graduate program requirements for the Graduate Certificate in Data Management.

Required Courses:

- SEIS 603 Foundations of Software Development - Python SEIS 630 Database Management Systems and Design
- SEIS 732 Data Warehousing and Business Intelligence
- SEIS 733 Database Administration Concepts
- SEIS 737 Big Data Management

Graduate Certificate in Embedded Systems

No longer enrolling for program effective Fall 2022

This certificate was created due to high demand in the job market for skills in embedded systems. Embedded systems are dedicated hardware/software controllers that deal with important and critical tasks we encounter every day, even though they might not necessarily be visible to end users.

Embedded systems are dedicated hardware/software controllers that support products such as televisions, appliances, medical devices, smart phones, and vehicles. Embedded systems deal with important and critical tasks we encounter every day, even though they might not necessarily be visible to end users.

Writing software for embedded systems is more difficult than writing more general computer applications because the systems often have few

resources, and often require real-time response. Also, software quality on embedded systems is extremely important because many of them are responsible for critical tasks in our everyday life. This certificate was created due to high demand in the job market for skills in embedded systems.

To complete the Graduate Certificate in Embedded Systems, the student must complete four required SEIS graduate courses (12 graduate semester credits) with at a GPA of 2.7 or better.

Required Courses:

- SEIS 740 Real-Time Systems and Applications
- SEIS 741 Embedded Microprocessor Design
- SEIS 742 Advanced Microprocessor
- SEIS 743 Computer Architecture

Graduate Certificate in Full Stack Development

The Graduate Certificate in Full Stack Development program helps professionals obtain the skills they need to develop full-stack applications. Full stack application developers who are experienced in both front-end and back-end development are highly valued by teams and employers for their ability to understand the 'big picture' of the web development process.

Full-stack development covers both the front-end development (website look and feel, and the parts the user interacts with) and the back-end development (servers, databases, and infrastructure required) of a system.

Students who complete this certificate will learn both front-end and back-end application development and will develop the necessary skills to construct online applications.

The curriculum of this certificate program includes foundational programming classes, the basics of software engineering, web application

development, and an introduction to database and server management.

Students have the option to use the coursework from their graduate certificate to continue in a Master of Science degree program offered by Graduate Programs in Software.

Required Courses:

- SEIS 601 Foundations of Java I
- SEIS 602 Foundations of Java II
- SEIS 610 Software Engineering
- SEIS 622 Web App Development
- SEIS 739 Software Analysis, Design, and Implementation

Graduate Certificate in Healthcare Analytics

The Graduate Certificate in Healthcare Analytics prepares professionals who need to handle the growing demands in analyzing digital healthcare information. This certificate program provides students with essential predicting, visualizing, and evaluating strategies that can improve the quality and safety of healthcare.

The courses in this certificate program require a working knowledge of SQL. Students must demonstrate adequate proficiency in this area or take SEIS 630 as a prerequisite before enrolling in these courses.

To complete the Graduate Certificate in Healthcare Analytics, the student must complete five graduate courses (15 graduate semester credits) with at a GPA of 2.7 or better.

Current and inactive students who enrolled in this program prior to fall 2018 may opt to remain with the graduate program requirements from their current catalog, or move forward to the newest graduate

program requirements for the Graduate Certificate in Healthcare Analytics.

Required Courses:

Students will be expected to have a prior background in Python or take SEIS603

Required Courses:

- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 639 Artificial Intelligence for Healthcare **or** (SEIS 763 Machine Learning **and** SEIS 764 Artificial Intelligence)
- SEIS 735 Healthcare Analytics and AI Case Study

Graduate Certificate in Digital Transformation

This graduate certificate prepares individuals to meet the growing demand from information technology (IT) industries for professionals skilled in Digital Transformation. IT

infrastructure deployment practices are rapidly changing as organizations build "Infrastructure as code" and adopt cloud computing platforms. The curriculum has been designed so that a student graduating from this certificate will be proficient in software engineering, information technology delivery, and cloud infrastructure.

This program focuses on real-world implementation challenges faced by IT organizations. Students will primarily learn by doing and gain hands-on experience with several widely adopted IT platforms. Students in the Graduate Certificate in Digital

Transformation program will learn about IT delivery, operations, and management in both theory and practice; software engineering concepts, techniques, and methodologies; and the engineering and design

of IT infrastructure, focusing on cloud-scale distributed systems and modern DevOps practices.

To complete the Graduate Certificate in Healthcare Analytics, the student must complete five graduate courses (15 graduate semester credits) with at a GPA of 2.7 or better.

Required Course:

Students will be expected to have a prior background in Python or take SEIS603

- SEIS 610 Software Engineering
- SEIS 615 Cloud Computing
- SEIS 616 Infrastructure as Code
- SEIS 666 Digital Transformation

Graduate Certificate in Internet of Things

No longer enrolling for program effective Fall 2022

The Graduate Certificate in Internet of Things provides an understanding of IoT technologies, architectures, standards, and regulation in order to build a roadmap to develop and implement IoT applications and solutions.

As billions of devices such as a smartwatch, home thermostat or refrigerator are getting connected to the Internet, the Internet of Things (IoT) has become one of the most talked about technology trends. These devices are able to collect, transmit the data and adapt its behavior based on usage, thus making them "smarter". The Graduate Certificate in Internet of Things provides an understanding of IoT technologies, architectures, standards, and regulation in order to build a roadmap to develop and implement IoT applications and solutions.

To complete the Graduate Certificate in Internet of Things, the student must complete four required SEIS graduate courses and one elective course (for a total of 12 graduate semester credits) with at a GPA of 2.7 or better.

Required Courses:

- SEIS 615 DevOps and Cloud Infrastructure
- SEIS 632 Data Analytics and Visualization
- SEIS 663 Information Technology Security and Networking
- SEIS 744 Internet of Things

Elective Courses: Choose one of the following

- ETL5 675 Digital Signal Processing I
- ETL5 676 Real Time DSP
- ETL5 751 Electromagnetic Fields and Waves
- SEIS 741 Embedded Microprocessor Design

Graduate Programs in Engineering

Master's in Electrical Engineering

The Master of Science degree in Electrical Engineering at the University of St. Thomas is a hands-on, industry-oriented and career-focused graduate program that blends theory and research with practical engineering fundamentals. Designed with considerable input from industry, the electrical engineering master's degree program provides our graduates with the in-depth technical skills necessary to succeed in a rapidly changing world and make immediate meaningful contributions to the technical vitality of the state of Minnesota.

The St. Thomas Master of Science degree in Electrical Engineering program has two options that are each worth 30 graduate credits: a course-based path, which requires completion of 10 graduate-level courses (30 credits), or a project-based path which requires completion of 8 courses (24 credits) and a design project (6 credits). This master's program can be pursued part-time or full-time with classes that meet weeknights and are designed to meet the needs of working professionals.

Graduate electrical engineering students focus their study in a particular area of electrical and computer

engineering by choosing one of the following concentration areas: Power Systems, Smart Grid and Electric Vehicles, Communications and Signal Processing, or Embedded Systems and Internet of Things (IoT).

To complete the requirements for the Master of Science in Electrical Engineering, students must successfully complete 10 courses (30 graduate semester credits) and maintain a GPA of at least 2.7.

10 Graduate courses = 30 credits

Choose one concentration:

- Power Systems
- Smart Grid and Electric Vehicles
- Communications and Signal Processing
- Embedded Systems and Internet of Things (IoT)

The **Power Systems** concentration emphasizes the study and control of power systems, distribution, renewable energy, electrical machines and power electronics. Power electronics enables the economic viability of renewable energy systems via its ability to transform electrical energy in one form to another with near 100% efficiency.

Required Courses (5 courses = 15 credits):

- ETL 744 Power Systems and Smart Grids
- ETL 746 Power Electronics
- ETL 747 Electrical Machines and Vehicles
- ETL 748 Renewable Energy Generation
- ETL 810 Advanced Controls

Technical Electives (5 courses = 15 credits):

Choose five technical electives from course list below

- ETL 620 Analog Communication Systems

- ETL 621 Digital Communication Systems
- ETL 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETL 631 Wireless Sensor Networks
- ETL 675 Digital Signal Processing
- ETL 676 Real Time DSP
- ETL 678 Wearable Systems, Data and IoT
- ETL 679 Embedded & Cyber Physical Systems
- ETL 699 Selected Topics
- ETL 739 EV Market and Technologies
- ETL 745 Power Systems Operations and Controls
- ETL 753 Power Systems Protection and Relay
- ETL 750 Smart Distribution Systems
- ETL 751 Electromagnetic Fields and Waves
- SEIS 631 Foundations of Data Analysis
- SEIS 663 Information Technology Security and Networking S
- EIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETL 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

The **Smart Grid and Electric Vehicles** concentration will prepare students to meet the challenges of the 21st century electric grid. Power engineers will lead the way in decarbonizing the electric grid and electrifying the transportation industry.

Required Courses (5 courses = 15 credits):

- ETLS 744 Power Systems and Smart Grids
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines and Vehicles
- ETLS 739 EV Market and Technologies
- ETLS 750 Smart Distribution Systems

Technical Electives (5 courses = 15 credits):

Choose five electives from the courses listed below

- ETLS 620 Analog Communication Systems
- ETLS 621 Digital Communication Systems
- ETLS 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETLS 631 Wireless Sensor Networks
- ETLS 675 Digital Signal Processing
- ETLS 676 Real Time DSP
- ETLS 678 Wearable Systems, Data and IoT
- ETLS 679 Embedded & Cyber Physical Systems
- ETLS 699 Selected Topics
- ETLS 745 Power Systems Operations and Controls
- ETLS 748 Renewable Energy Generation
- ETLS 751 Electromagnetic Fields and Waves
- ETLS 753 Power Systems Protection and Relay
- ETLS 810 Advanced Controls
- SEIS 631 Foundations of Data Analysis
- SEIS 663 Information Technology Security and Networking

- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLS 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

The **Communications and Signal Processing**

concentration focuses on the study of communication and processing of information, which is the foundation for all of our digital lives. Applications can be found in all areas around us such as IoT, wearables, mobile health care, autonomous vehicles, Artificial Intelligence, and communication of such information over a variety of communication networks such as Wifi, Bluetooth, 4G LTE, and 5G wireless networks.

Required Courses (5 courses = 15 credits):

- ETLS 620 Analog Communication Systems
- ETLS 621 Digital Communication Systems
- ETLS 631 Wireless Sensor Networks
- ETLS 675 Digital Signal Processing
- ETLS 678 Wearable Systems, Data and IoT

Technical Electives (5 courses = 15 credits):

Choose five electives from the course list below

- ETLS 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETLS 676 Real Time DSP
- ETLS 679 Embedded & Cyber Physical Systems
- ETLS 699 Selected Topics
- ETLS 739 EV Market and Technologies
- ETLS 744 Power Systems and Smart Grids
- ETLS 745 Power Systems Operations and Controls

- ETLs 746 Power Electronics
- ETLs 747 Electrical Machines
- ETLs 748 Renewable Energy Generation
- ETLs 750 Smart Distribution Systems
- ETLs 751 Electromagnetic Fields and Waves
- ETLs 753 Power Systems Protection and Relay
- ETLs 810 Advanced Controls
- SEIS 631 Foundations of Data Analysis
- SEIS 663 Information Technology Security and Networking
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLs 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

The **Embedded Systems and Internet of Things (IoT)** concentration enables students to become proficient with microcomputers, sensors, interconnections and their composite systems used to design and control devices impacting many aspects of our daily lives from smart homes and cars to pacemakers and wearable devices.

Required Courses (5 courses = 15 credits):

- ETLs 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETLs 631 Wireless Sensor Networks
- ETLs 676 Real Time DSP
- ETLs 678 Wearable Systems, Data and IoT
- ETLs 679 Embedded & Cyber Physical Systems

Technical Electives (5 courses = 15 credits):

Choose five electives from the course list below

- ETLs 620 Analog Communication Systems
- ETLs 621 Digital Communication Systems
- ETLs 675 Digital Signal Processing
- ETLs 699 Selected Topics
- ETLs 739 EV Market and Technologies
- ETLs 744 Power Systems and Smart Grids
- ETLs 745 Power Systems Operations and Controls
- ETLs 746 Power Electronics
- ETLs 747 Electrical Machines
- ETLs 748 Renewable Energy Generation
- ETLs 750 Smart Distribution Systems
- ETLs 751 Electromagnetic Fields and Waves
- ETLs 753 Power Systems Protection and Relay
- ETLs 810 Advanced Controls
- SEIS 631 Foundations of Data Analysis
- SEIS 663 Information Technology Security and Networking
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLs 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

Master's in Manufacturing Engineering

The Manufacturing Engineering master's program offers professionals with engineering, science or liberal arts backgrounds an opportunity to strengthen their engineering management and leadership skills. Through study of best practices and ideas in the

context of real-world manufacturing and service systems, students gain the skills and confidence to handle daily operations and make better decisions.

The Master of Science degree in Manufacturing Engineering develops individuals with leadership depth and technical breadth for engineering management positions in a manufacturing or service industry. Coursework focuses on manufacturing engineering problem solving, strategic quality and performance management, and decision making. This program helps you to gain a competitive edge for acquiring more challenging assignments and responsibilities, and to develop a network of experts in your field.

The Manufacturing Engineering program offers professionals with engineering, science or liberal arts backgrounds an opportunity to strengthen their engineering management and leadership skills. Students learn to view their organizations as systems - networks of customers, technologies, markets, distribution channels and people. Through study of best practices and ideas in the context of real-world manufacturing and service systems, students gain the skills and confidence to handle daily operations and make better decisions.

Effective fall 2015, to complete the requirements for the Master of Science in Manufacturing Engineering, students must successfully complete 10 courses (30 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (10 courses = 30 total credits) Core Courses (All 5 courses required = 15 Credits):

- ETL5 501 Production and Operations Systems
- ETL5 502 Manufacturing Processes
- ETL5 505 Managerial Accounting and Performance Management
- ETL5 506 Statistical Methods for Manufacturing Quality
- ETL5 858 Engineering Capstone

Quality Systems and Processes (1 course required = 3 credits):

Choose one course from this topic area

- ETL5 551 Strategic Quality Management
- ETL5 640 Lean Six Sigma
- ETL5 701 Design of Experiments
- ETL5 722 Medical Device Quality Systems

Supply Chain (1 course required = 3 credits):

Choose one course from this topic area

- ETL5 552 Supply Chain Synchronization
- ETL5 570 Purchasing, Logistics and Distribution
- ETL5 851 Enterprise Information Systems or SEIS 709 Enterprise Architecture and Strategy

Management (1 course required = 3 credits):

Choose one course from this topic area

- ETL5 601 Program/Project/Team Management
- ETL5 671 Human Aspects of Technical Management
- ETL5 853 Managing Intellectual Property

Leadership (1 course required = 3 credits):

Choose one course from this topic area

- ETL5 652 Technology Forecasting and Risk Management
- ETL5 660 Engineering Leadership

Related Elective (1 course required = 3 credits):

Choose one course from this topic area

- ETL5 504 Excellence in Operations
- ETL5 520 Design and Manufacturing in the Medical Device Industry
- ETL5 677 Sustainable Development Strategies
- ETL5 699 Special Topics Course
- ETL5 720 Anatomy and Physiology for Medical Devices
- ETL5 723 Biomaterials in the Design of Medical Devices
- ETL5 770 Automated Control of Manufacturing Processes
- ETL5 771 Materials Engineering
- Biomaterials in the design of medical devices
- Mechatronics
- Electrical machines, renewable energy, advanced engineering materials, finite element analysis, or circuit analysis
- Simulation and visualization of dynamic systems

To complete the requirements for the Master of Science in Mechanical Engineering, students must successfully complete 10 courses (30 graduate semester credits) and maintain a GPA of at least 2.7.

Degree plan for students with a bachelor's degree in mechanical engineering or related program:

Total Courses (10 courses = 30 credits)

Select four courses in Design, four courses in Analysis, and two electives.

Core Requirements: Design (4 courses required = 12 credits)

Select four courses:

- ETL5 501 – Production Operations Systems
- ETL5 502 – Manufacturing Processes (design of manufacturing processes) ETL5 520 – Design and Manufacturing in the Medical Device
- ETL5 555 – Advanced Product Design ETL5 591 – Advanced Thermal Systems ETL5 672 – Excellence in Product Design ETL5 701 – Design of Experiments
- ETL5 723 – Biomaterials in the Design of Medical Devices ETL5 773 – Principles of MEMS Product Development ETL5 774 – Introduction to Mechatronics
- ETL5 775 – Polymers in Design ETL5 777 – Finite Element Analysis
- Production operations systems, product development
- Manufacturing processes and statistical methods
- Advanced product design, thermal systems, polymer or experimental design

Master's in Mechanical Engineering

The popular Master of Science in Mechanical Engineering program prepares students to be successful in the broad area of advanced design and analytical skills. This flexible master's curriculum offers two different degree plans to choose from depending on your educational background: 1) for students who already have a Mechanical Engineering bachelor's degree; or for students who have a bachelor's degree in other areas of study.

Students with a bachelor's degree in Mechanical Engineering select four courses in Design, four courses in Analysis, and two electives. Students with a bachelor's degree and who do not have a Mechanical Engineering background are required to take four graduate foundational courses, three courses in Design and three in Analysis. Subject areas include:

Core Requirements: Analysis (4 courses required = 12 credits)

Select four courses:

- ETLS 506 – Statistical Methods for Manufacturing Quality
- ETLS 591 – Advanced Thermal Systems
- ETLS 701 – Design of Experiments ETL 746 – Power Electronics
- ETLS 747 – Electric machines and Vehicles
- ETLS 748 – Renewable Energy Generation
- ETLS 776 – Advanced Engineering Materials
- ETLS 777 – Finite Element Analysis
- ETLS 789 – Simulation and Visualization of Dynamic Systems

Elective Courses: (2 courses required = 6 credits)

You may choose two electives from the ETL or SEIS course catalog or ETL 881/882 Engineering Project electives.

Master's Degree plan for students who have a bachelor's degree in a non-STEM field:

Total Courses (10 courses = 30 credits): Complete all four recommended foundational courses and select three courses in Design and three courses in Analysis.

Core Requirements: Foundational (4 courses required = 12 credits)

Complete all four recommended foundational courses prior to taking the Design and Analysis courses.

- ETL 502 – Manufacturing Processes
- ETL 503 – Engineering Mechanics
- ETL 771 – Materials Engineering

- ETL 741 – Heat Transfer and Fluid Mechanics

Core Requirements: Design (3 courses required = 9 credits)

Select three courses:

- ETL 501 – Production Operations Systems
- ETL 520 – Design and Manufacturing in the Medical Device
- ETL 555 – Advanced Product Design
- ETL 591 – Advanced Thermal Systems
- ETL 672 – Excellence in Product Design
- ETL 701 – Design of Experiments
- ETL 723 – Biomaterials in the Design of Medical Devices
- ETL 773 – Principles of MEMS Product Development
- ETL 774 – Introduction to Mechatronics
- ETL 775 – Polymers in Design
- ETL 777 – Finite Element Analysis

Core Requirements: Analysis (3 courses required = 9 credits)

Select three courses:

- ETL 506 – Statistical Methods for Manufacturing Quality
- ETL 511 – Circuit Analysis
- ETL 591 – Advanced Thermal Systems ETL 701 – Design of Experiments
- ETL 746 – Power Electronics
- ETL 747 – Electric machines and Vehicles
- ETL 748 – Renewable Energy Generation

- ETLS 776 – Advanced Engineering Materials
- ETLS 777 – Finite Element Analysis
- ETLS 789 – Simulation and Visualization of Dynamic Systems

Master's in Regulatory Science

Designed for those interested in transitioning into the field of Regulatory Science. It is also intended for new regulatory professionals who recognize the need to acquire a broader understanding of regulatory requirements and how to achieve them. The program covers submissions, clinical studies, quality systems, international submissions, device manufacturing, combination products and other regulatory topics.

Medical Device regulatory professionals make a difference in people's lives. These are the men and women who navigate the government's laws and regulations to bring lifesaving and life-enhancing technology to patients. Chances are you know someone whose quality of life has been enhanced due to a medical device. If you are looking for a satisfying, high-paying, in-demand position in this high-growth field, then Regulatory Science may be a great choice for you.

Students in this program will learn how to interpret and apply a very broad array of current regulatory requirements for medical devices and combination products. They will also acquire skills allowing them to implement future changes in regulations, guidance documents and standards. Students are encouraged to select courses, projects and presentations throughout their program that will best serve their professional interests.

Classes are taught evenings and weekends, by knowledgeable and experienced working professionals from the Twin Cities area medical device industry.

To complete the requirements for the Master of Science with a major in Regulatory Science, students must successfully complete 33 graduate semester credits and maintain a GPA of at least 2.7.

Students must complete 27 core credits (9 required courses) from Engineering and an additional 6 elective credits from either the School of Engineering graduate course curriculum, Graduate Business classes listed below or other graduate St. Thomas program subject to Faculty Advisor approval.

Abbreviations:

ETLS = Graduate Engineering Courses

BCOM = Graduate Business Communications Courses

SEIS = Graduate Software Engineering Courses

Required Courses:

- ETLS 520 Design and Manufacturing in Medical Device Industry
- ETLS 660 Engineering Leadership
- ETLS 721 Medical Device Regulatory Submission
- ETLS 722 FDA Medical Device Quality Systems
- ETLS 724 Medical Device Clinical Studies
- ETLS 731 Combination Products, Drugs and Biologics
- ETLS 735 Preclinical Activities
- ETLS 737 International Regulatory Affairs for Medical Devices
- ETLS 880 Regulatory Science Project

Elective Courses:

Select elective courses [6 credits] from the Regulatory Science curriculum or any other St. Thomas graduate course list (provided you have the prerequisites met and your faculty advisor has given approval).

Preferred Regulatory Science electives:

- ETLS 601 Program/Project/Team Management

- ETLS 720 Anatomy, Physiology and Medical Devices
- ETLS 734 Clinical Evidence and Reimbursement
- Other Popular Regulatory Science electives include:
- ETLS 501 Production Operating Systems
- ETLS 502 Manufacturing Processes
- ETLS 571 Automation in the US and Overseas
- ETLS 671 Human Aspects of Technical Management
- ETLS 771 Materials Engineering
- BCOM 535 Persuasion
- BCOM 543 Team Skills and Group Processes
- BCOM 551 Presentational Speaking
- BCOM 640 Technical Writing
- SEIS 605 Technical Communications

Master's in Systems Engineering

Systems Engineering: an applications-oriented master's program designed to enable the student to transition from the role of a domain-expert Engineer to a Systems Engineer, and is intended for people who need to design, develop and manage large and complex systems in industry. Major emphasis is placed on System Design, Verification & Validation, Simulation, and Project Management.

The Master of Science degree in Systems Engineering is an applications-oriented Master's program designed to enable the student to transition from the role of a domain-expert Engineer to a Systems Engineer, and is intended for people who need to design, develop and manage large and complex systems in industry. Major emphasis is placed on

System Design, Verification & Validation, Simulation, and Project Management.

Systems Engineering expands the capabilities of engineers by applying proven structured methodologies to broaden perspective and hone problem solving skills. The increased complexity of technologies ranging from medical devices to manufacturing designs to larger systems of networked devices require a systems perspective.

The School of Engineering at the University of St. Thomas provides a Systems Engineering curriculum designed to prepare students to earn the title of 'Systems Engineer'.

To complete the requirements for the Master of Science in Systems Engineering, students must successfully complete 10 courses (30 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (6 courses = 18 total credits):

- ETLS 507 Introduction to Systems Engineering
- ETLS 508 Systems Design
- ETLS 509 Verification and Validation
- ETLS 601 Program/Project/Team Management
- ETLS 789 Simulation & Visualization of Dynamic Systems
- ETLS 881 – Engineering Project (preapproved by advisor)

Electives:

Choose any 4 courses from the electives listed below = 12 credits

Financial and Accounting Electives:

- ETLS 505 Managerial Accounting and Performance Management

Management and Leadership Electives:

- ETLS 671 Human Aspects of Technical Management
- ETLS 660 Engineering Leadership

Modeling and Simulation Electives:

- ETLS 777 Finite Element Analysis
- ETLS 810 Advanced Controls

Software Electives:

- SEIS 601 Foundations of Software Development
- SEIS 610 Software Engineering
- SEIS 635 Software Analysis and Design
- SEIS 640 Operating Systems Design
- SEIS 663 IT Security and Networking

Medical Device Electives:

- ETLS 520 Design & Manufacturing in the Medical Device Industry
- ETLS 722 FDA Medical Device Quality Systems
- ETLS 724 Medical Device Clinical Studies
- ETLS 731 Combination Products, Drugs and Biologics
- ETLS 737 Int'l Regulatory Affairs for Medical Devices

Technical Electives:

- ETLS 501 Production Operating Systems
- ETLS 506 Statistical Methods for Manufacturing Quality Systems
- ETLS 701 Design of Experiments
- ETLS 744 Power Systems

Master's in Technology Management

People who thrive amid chaos, think strategically and understand complexity are valuable assets in industries with rapidly changing technologies. The Master of Science degree in Technology Management program is designed to develop such leaders and support the continued professional development needs of leaders in technology-based industries.

Graduates will be equipped to manage their organization's technical resources, lead technological change, and integrate technology into the strategic objectives of their firms.

The M.S. in Technology Management is a well-designed master's program for those interested in successfully leading technology driven companies. The program explores Finance & Accounting, Quality, Team & Project Management, Risk Assessment, Intellectual Property, Enterprise Systems, Tech Forecasting, and Leadership.

To complete the requirements for the Master of Science in Technology Management, students must successfully complete 12 graduate-level courses (36 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (9 courses = 27 total credits):

- ETLS 505 Managerial Accounting and Performance Management
- ETLS 551 Strategic Quality Management
- ETLS 552 Supply Chain Synchronization
- ETLS 601 Program/Project/Team Management
- ETLS 652 Tech Forecasting & Risk Management
- ETLS 660 Engineering Leadership
- SEIS 709 Enterprise Architecture and Strategy
- ETLS 853 Managing Intellectual Property

- ETL 858 Engineering Capstone

Related Electives (3 courses = 9 credits):

With your advisor and choose three elective courses. Examples of electives often taken by M.S. in Technology Management students are:

- ETL 504 Excellence in Operations
- ETL 506 Statistical Methods for Manufacturing Quality
- ETL 640 Lean Six Sigma
- ETL 671 Human Aspects of Technical Management

Graduate Programs in Engineering Certificates

The St. Thomas School of Engineering offers four graduate certificates that provide industry leaders and career changers an opportunity to specialize in the areas of Manufacturing, Medical Device, Power Electronics, and Technology Management to advance their career. In just four or five courses students will earn a graduate certificate to bolster their resume and many of the graduate certificates can be applied toward a future master's degree.

Graduate Certificate in Manufacturing Systems

The Manufacturing Systems certificate is designed to meet the needs of those who want a basic understanding of manufacturing systems and methods. It was created for manufacturing professionals who want to upgrade their skills or take on a new assignment or position.

Students have the option to use coursework from their graduate certificate to continue in a Master of Science degree offered through the School of Engineering at the University of St. Thomas.

To complete the requirements for the Graduate Certificate in Manufacturing Systems, students must

successfully complete 5 courses (15 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (3 courses = 9 total credits):

- ETL 501 Production and Operations Systems
- ETL 502 Manufacturing Processes
- ETL 506 Statistical Methods for Manufacturing Quality

Elective Courses:

Choose two courses (six credits)

- ETL 505 Managerial Accounting and Performance Management
- ETL 551 Strategic Quality Management
- ETL 570 Purchasing, Logistics, and Distribution
- ETL 601 Program/Project/Team Management
- ETL 660 Engineering Leadership

Graduate Certificate in Medical Device Development

The Graduate Certificate in Medical Device Development is designed to meet the needs of the rapidly growing medical device industry. This program supports the unique needs of people currently working in or just beginning a career in this industry. As with any rapidly growing industry, applied education that can be put to use immediately is extremely important. The Medical Device Development Certificate offers applied education in the common areas of medical device development and manufacture.

Who can benefit from the Medical Device Development Certificate?

- Professionals taking a new assignment or position

- Professionals who want to upgrade skills
- Managers who want to know more about the multidisciplinary teams they manage
- Team members who want to understand the scope of the projects they are working on
- Suppliers of materials to the medical device industry

Students have the option to use coursework from their graduate certificate to continue in a Master of Science degree offered through the School of Engineering at the University of St. Thomas.

A total of 15 graduate semester credits and maintain a GPA of at least 2.7 is required.

Required Courses (4 courses= 12 credits):

- ETLS 520 Design Manufacturing in the Medical Device Industry
- ETLS 721 Medical Device Regulatory Submissions
- ETLS 722 Medical Device Quality Systems
- ETLS 724 Medical Device Clinical Studies

Elective Courses:

Choose one course (three credits)

- ETLS 720 Anatomy & Physiology for Medical Devices
- ETLS 731 Combo Products, Drugs and Biologics
- ETLS 734 Clinical Evidence and Reimbursement
- ETLS 735 Preclinical Activities
- ETLS 737 International Regulatory Affairs for Medical Devices

Graduate Certificate in Power Electronics and Systems

Several prevailing factors combine to make the new University of St. Thomas Graduate Certificate in Power Electronics and Systems exciting, relevant, and essential. These factors include:

The penetration of alternative energy systems (Distributed Energy Resources - DERs) into the legacy power grid, the aging workforce in the US power business sector, the advent of the microgrid and the humanitarian/sustainable evolution in developing countries where microgrids may leap-frog grid-deployment itself (much like cellular communications which have leap-frogged copper-to-the-home in these countries) power-electronics that make it all possible.

These factors, along with the UST Renewable Energy and Alternatives Laboratory (REAL), provide the foundation for an innovative certificate program that can further evolve into the Master of Science in Electrical Engineering from the University of St. Thomas.

To complete the requirements for the Graduate Certificate in Power Electronics and Systems, students must successfully complete 4 required courses (12 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (4 courses = 12 total credits):

Four required courses (12 credits) are required for this certificate. As an extension to the four required courses, students may also complete the optional 3-credit course ETLS 745 Power Systems Operations and Controls.

Required Courses:

- ETLS 744 Introduction to Power Systems
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines
- ETLS 748 Renewable Energy Generation

Optional Elective Course:

- ETLS 745 Power Systems Operations and Controls

Graduate Certificate in Technology Leadership

The Technology Leadership Certificate is designed to meet the needs of those wanting to improve manufacturing quality and methods by managing people and the supply chain more effectively. It was created for professionals who want to upgrade their skills or take on a new assignment or position.

Students have the option to use coursework from their graduate certificate to continue in a Master of Science degree offered through the School of Engineering at the University of St. Thomas.

To complete the requirements for the Graduate Certificate in Technology Leadership, students must successfully complete five courses (15 graduate semester credits) and maintain a GPA of at least 2.7.

Required Courses (4 courses = 12 total credits):

- ETLS 505 Managerial Accounting and Performance Management
- ETLS 551 Strategic Quality Management
- ETLS 601 Program/Project/Team Management
- ETLS 660 Engineering Leadership

Elective Course:

Choose one course (three credits)

- ETLS 552 Supply Chain Synchronization
- ETLS 652 Tech Forecasting and Risk Management
- SEIS 709 Enterprise Architecture and Strategy
- ETLS 853 Introduction to Intellectual Property Law

To receive the Technology Leadership certificate students must complete all of the four listed, required courses, and one elective selected only from this list. No exceptions.

Graduate Programs in Engineering Course Catalog

ETLS 501 PRODUCTION AND OPERATIONS SYSTEMS

A comprehensive review of modern production methods and systems for production and service industries. Topics include location and facility layout, job design and measurement, group technology, push/pull systems, process planning, forecasting, production and capacity planning, scheduling and manufacturing systems. The course also provides a brief review of FMC, FMS, CNC, DNC and computer-integrated manufacturing.

ETLS 502 MANUFACTURING PROCESSES

The course provides an overview of engineering solid mechanics. An effort will be made to apply theory to practice relating to typical industrial problems faced by today's engineering companies. A complete understanding of these topics is required for the application of engineering knowledge in the solid mechanics. This course provides the foundation for many of the courses which follow.

ETLS 504 EXCELLENCE IN OPERATIONS

An advanced course in concepts essential to achieving excellence in operations. The course covers the development and implementation of a coherent manufacturing strategy consistent with business and corporate strategies; importance of global competitiveness; and structuring of the production process based on the manufacturing mission. The human interaction involved in current quality issues, Just In Time (JIT), Total Productive Maintenance (TPM), set-up time reduction, simultaneous engineering, lean manufacturing and contemporary logistics systems, employee involvement and teamwork are key concepts of this course.

ETLS 505 MANAGERIAL ACCOUNTING AND PERFORMANCE MANAGEMENT

This course integrates the concepts of financial accounting, cost accounting and performance measurement as they are applied to the enterprise. The course emphasizes the concepts, terms, and techniques for using accounting and measurement information in planning decision-making, and performance evaluation. Topics include analysis of financial statements, manufacturing and operations costs, fixed and variable costs, capital investment analysis, pricing, job and process cost systems, budgeting, responsibility accounting, cost allocation and activity-based costing. Also covered are operational measures emphasizing physical units, process analysis, productivity measurement, and other non-accounting operational key indicator measurements. Consideration is also given to the influence of such concepts as Total Quality Management (TQM) Just-In-Time (JIT), Benchmarking, the Balanced Scorecard, Re-engineering, Six Sigma and Baldrige Awards as they relate to accounting and performance measurements.

ETLS 506 STATISTICAL METHODS FOR MANUFACTURING QUALITY

An introduction to the basic philosophy of the statistical tools used to assure manufacturing quality. Tools to include: hypothesis testing, regression analysis, analysis of variance, process capability, control charts (SPC) and six sigma. Students will conduct and report an industrial based statistical application project.

ETLS 507 INTRODUCTION TO SYSTEMS ENGINEERING

This course considers the engineering of both natural and human-made systems as well as the analysis of those systems. The course will convey to the students the essential elements of systems engineering; including systems

thinking, systems analysis, system architecture, the decomposition and re-composition of systems design, risk management, reliability, maintainability and availability, and the coherent structure of a systems view.

ETLS 508 SYSTEMS DESIGN

This course provides the student with an overview of the processes involved in the analysis, design, and implementation of systems. This is a hands-on course and is targeted at graduate students. Topics to be covered include the development life cycle, feasibility studies, requirements analysis, systems analysis, and systems design. Systems analysis and design methods covered in this course include both a software and hardware approach. Module 1 - Systems Analysis Fundamentals Module 2 - Practical Systems Analysis Module 3 - Practical Systems Design Module 4 - Introduction to Object Orientation During the semester, the student will be involved in the analysis and design of a complex system. This project is an important part of the course because it provides the opportunity to confront real-life situations and problems during the systems analysis and design process. It is, therefore, essential for the student to be actively involved in this project. Students are required to learn the necessary technology to contribute to the project in a meaningful way.

Prerequisite: ETLS 507 Introduction to Systems Design

ETLS 509 VERIFICATION & VALIDATION

This course considers two closely related but distinct concepts in systems engineering, verification and validation. Verification is "The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase." (IEEE Standard Glossary of Software Engineering Terminology, Standard 610.12-1990.) Validation

is the act of assessing the requirements, design, and development of a product to ensure that it will meet the user's requirements, operational needs, and expectations at the time of delivery. Systems engineering verification and validation practices will be studied and applied in appropriate situations. Prerequisite: ETLS 508 - Systems Design

ETLS 511 CIRCUIT ANALYSIS

Introduction to linear circuit analysis and basic electronic instrumentation. Students will learn linear models of passive components and sources as well as how real components depart from those models. Circuit analysis techniques including nodal and mesh analysis, equivalence theorems and computer simulation will be covered. Laplace transform techniques will be used to examine sinusoidal steady state and transient circuit behavior.

Prerequisite: A minimum grade of C- in PHYS 112 or 212, and concurrent registration with or prior completion of MATH 114.

NOTE: Students who receive credit for ENGR 240 or ENGR 350 may not receive credit for this class.

ETLS 512 CONTROL SYSTEMS AND AUTOMATION

An introduction to the scope of control systems in manufacturing and their implementation. The course focuses on analog control loop theory, the use of transforms to describe and solve analog control systems. Emphasis is placed on the development and implementation of proportional, integral derivative (PID) control algorithms. Simulation is emphasized as an important tool for plant design, layout and optimizing systems.

Prerequisite: ETLS 511

Note: Students who receive credit for ENGR 410 may not receive credit for ETLS 512.

ETLS 520 MANUFACTURING IN MEDICAL DEVICE INDUSTRY

This course is designed to provide an introductory overview of the medical device industry, and its unique design and manufacturing challenges. The course first examines the industry itself, reviewing basic industry statistics, current trends, and the many types of products that make up the medical device industry. It then helps students understand the fundamental systems that are used in the design, development and manufacture of medical devices and how these related to regulations governing the development and manufacturing processes. Finally the course explores in detail some of the unique aspects of manufacturing a medical product such as special material and process selection considerations, clean rooms, sterile packaging, sterilization processes, clinical testing, lot traceability and manufacturing control.

EGED 530 FUNDAMENTALS OF ENGINEERING FOR EDUCATORS

This is a one-semester survey of engineering topics. Topics will span machine design, manufacturing, thermodynamics, electronics, computer programming, and chemical engineering. The course will have weekly lab sessions which will allow students to apply what they are learning from lectures in a hands-on setting. Emphasis will be placed on how the material is used by practitioners. Numerous examples will be given of how this material can be presented in a way that meets Minnesota education standards. Each topics unit will include a component dedicated to the historic and current relevance of the concepts and skills presented. Whenever appropriate, and feasible, guest lectures and field trips will be arranged. The goal of this course is to provide teachers with a short, hands-on introduction to a variety of engineering.

ETLS 551 STRATEGIC QUALITY MANAGEMENT

Strategic quality management is presented as a Driver--> System--> Results model. The DSR model provides a framework for better

understanding your business and when and where to take action to improve results. The model is a tool that links company mission, strategic plans, competitive positioning, and customer focus as the DRIVER. People and processes form the SYSTEM that actually designs, produces, and delivers products and services. RESULTS include financial, customer, employee and process. The course also connects the DSR model to the Malcolm Baldrige Criteria for Performance Excellence, six sigma and lean improvement tools ISO 9000, and Quality Management Systems and tools such as Statistical Process Control (detailed training in tools such as SPC is not part of the class). In addition to developing an understanding of how to guide and manage quality strategically, the course also helps to identify and prioritize the "right questions to ask" to guide and manage tactically. Applying the course to real world situations should lead to improved results - financial, customer, employee and process.

ETLS 552 SUPPLY CHAIN SYNCHRONIZATION

This applications-oriented course will review key topics in supply chain management and integrate these topics with current management thinking in lean manufacturing and six sigma. A systems thinking approach that maps logistics, forecasting, warehousing, transportation, and information systems will be combined with discussions of vendor and customer relationships, motivations, and ethics to work toward a smoothly functioning supply system. Students will use proven industrial engineering and management principles, techniques and tools to design a supply chain for their industry, efficiently and effectively plan and layout manufacturing operations, and improve processes to eliminate waste.

ETLS 555 ADVANCED PRODUCT DESIGN

Detailed discussion of product design and development for engineers. This lecture-based

course focuses on medical device product design, yet it draws many examples from other industries. Students will learn the product development cycle beginning with initial market analysis and proceeding through manufacturing. The course introduces many statistical analysis tools and procedures as the basis for rigorous decision making in product design. General design topics include voice-of-customer research; technical product requirements; project planning and schedules; measurement system analysis; comparative testing; design of experiments; robust design; manufacturing process control; and product reliability.

ETLS 570 PURCHASING, LOGISTICS AND DISTRIBUTION

An introduction to the operations aspects of logistics combined with an overview of Supply Chain Management. Topics will include purchasing, vendor relations, inventory strategies and control, warehousing, material handling, packaging, and transportation, combined under supply chain management philosophy. The course will be taught through lectures, problem sets, case studies, guest speakers, and a tour of a high volume, order fulfillment facility.

Prerequisite: ETLS 505 Managerial Accounting and Performance Management is recommended but not required.

ETLS 571 AUTOMATION SYSTEMS IN THE US AND OVERSEAS

This course provides an examination of automation and the processes and systems in which it works. The course focuses on electronic, electromechanical and mechanical manufacturing and also touches on highly automated molding and its tooling. Topics include flexible and hard automation within a variety of systems environments. The course moved from automation basics to design for automation followed by a hard look at the processes such as group technology, sensors, and systems that allow for and improve automation. The course consists of lectures,

guest speakers' videos and visits to factories and laboratories.

ETLS 591 ADVANCED THERMAL SYSTEMS

This course provides a broad instruction in the design and analysis of advanced thermal systems. Analysis techniques will include both analytical and numerical methods. Application areas include biomedical, aerospace, manufacturing, HVAC, and other industries.

ETLS 601 PROGRAM PROJECT TEAM MANAGEMENT

Focusing on the applications of project management, students gain insight and understanding of the day-to-day activities of project management (including cost analysis and scheduling techniques) and exposure to software options. A significant portion of the course focuses on conflict resolution, time management, leadership, and other personnel-related topics with the goal that engineers might effectively carry out the requirements of their companies without paying a penalty in lost good will or personnel.

ETLS 602 MANAGEMENT SCIENCE

On one-level, management science is a set of tools based on mathematical models of business actions such as allocating resources, planning production, scheduling work, and managing inventory. On another level, it is computer software that implements these models and converts business data into useful solutions. At a higher level, management science is a philosophy of observation and analysis of business systems with the goal of minimizing costs and maximizing resource utilization and profit. This course looks at all three levels with emphasis on generating computer solutions and interpreting and implementing the results.

Prerequisites: ETLS 504 Excellence in Operations (MMSE 510) and ETLS 506 Statistical Methods for Manufacturing Quality (MMSE 615)

ETLS 620 ANALOG COMMUNICATION SYSTEMS

Introduction to Fourier analysis of noise and signals, analog modulation techniques including amplitude modulation, frequency modulation, and phase modulation, pulse code modulation, behavior of analog communication systems in the presence of noise, information theory, and source coding.

Prerequisite: ENGR 340 or approval from instructor.

ETLS 621 DIGITAL COMMUNICATION SYSTEMS

Sampling principle, spectral analysis of digital waveforms and noise, pulse and digital transmission systems, digital multiplexing, error probabilities, and system performance.

Prerequisite: ETLS 620

ETLS 631 WIRELESS SENSOR NETWORKS

This course will introduce students to the concepts and principles of sensor network communications. Applications, architectures, and communication protocols for wireless sensor networks are treated in depth. The course will include broad coverage of challenges and the latest research results related to the design and management of wireless sensor networks. Covered topics include network architectures, node discovery and localization, deployment strategies, node coverage, routing protocols, medium access protocols, and energy efficiency. Students will also develop real-world sensor networks applications such as mobile health care, wearable sensing, or smart homes. *Registration requires the consent of the instructor.

ETLS 640 LEAN SIX SIGMA

Lean Six Sigma is a course designed to promote an understanding of two popular international methodologies – Lean and Six Sigma. A brief overview of the origin and definition of each will then be followed by an extensive review and understanding of concepts, principles and tools. Through lecture, group discussions, hands-on simulations, team exercises and guest speakers,

students will develop knowledge of the inter-relationship of these two methodologies and how to implement for product and process improvement in all types of organizations and throughout all functional areas. Soft skills will also be covered such as working with cross-functional teams, driving organizational change and leading in a Lean Six Sigma culture. This course will not include the use of any statistical analysis tools. This course will provide a framework for students who plan to pursue Lean or Six Sigma certification.

ETLS 652 TECHNOLOGY FORECASTING AND RISK MANAGEMENT

The course will develop approaches to analyzing the technological environment and attendant risk exposure and anticipating future changes through lecture, discussion, group assignments, readings, books, and individual projects will reinforce key course concepts. Each student will choose a specific topic for study such as a technology or set of related technologies, an industry or market, or an economic/political region or country and will develop materials that can be applied in anticipating future technological and social change in the topic area. These student topics will form part of class discussions. Students should be prepared to discuss their progress as it relates to topics being developed in class.

Prerequisite: None

ETLS 660: ENGINEERING LEADERSHIP

Three observations inform this course: Engineers at every level of an organization can exhibit leadership, amplifying their contribution and effectiveness. And many engineers who are asked to assume leadership roles do so without the benefit of leadership education or a 'roadmap' for their role. Yet, the core capabilities, competencies, principles, and practices of highly effective leaders are relatively consistent and can be developed.

This course is designed to develop engineering students' leadership capabilities by building their own

'roadmap' for their leadership, increasing clarity about one's self as a leader, strengthening their awareness for interpersonal and leadership effectiveness within organizations, and sharpening their capability for managing their leadership development

throughout their career and life. It is designed to address the basic questions of what makes for a highly effective leader: "who am I as a leader?", "how do I exhibit my leadership?", and "how do I develop my leadership?"

This course is conducted in a seminar format, with emphasis on assimilation and application of conceptual models from multiple readings and of personal assessments through small and large group discussion, exercises and case scenarios, personal feedback, writing assignments and presentations.

ETLS 670 MASTERFUL LEADERS AND LEADERSHIP

This course challenges the learner to make a fundamental decision to refocus their minds in a leadership way of thinking which is about personal maturity and its impact on the bottom line. The focus is on emotional intelligence, culture and leadership greatness.

ETLS 671 HUMAN ASPECTS OF TECHNICAL MANAGEMENT

Managers use written, oral and non-verbal communication to accomplish many purposes. This course teaches the student techniques and practice skills for targeting your audience, coaching and supporting employees, interviewing, salesmanship, performance management, personnel selection and employee development, conflict management, running meetings, problem solving and decision making, teamwork, networking and customer and vendor relationships.

ETLS 672 EXCELLENCE IN PRODUCT DESIGN

This course focuses on the key elements which define "excellence in product design". The underlying constituent criteria for design excellence are explored in depth. The role of the industrial designer will be

considered. Examples of good and bad design will be considered. Industry experts with experience in industrial design and product design will serve as guest lecturers in a format designed to stimulate a high level of interaction and discussion. Each student will, through class discussion, reading, tours, presentations, personal research and book reviews, approach what "design excellence" means for him/herself.

ETLS 675 DIGITAL SIGNAL PROCESSING I

This course discusses topics on the fundamentals of continuous and discrete-time signals, sampling, time-frequency analysis, filters, Machine Learning and Neural Network. Applications include speech, audio, image, video and biomedical signal processing, signal compression, and multi-dimensional sensor data analysis. Prior experience with MATLAB/Python is highly recommended.

ETLS 676 REAL TIME DSP

This class focuses on the design, development, and implementation of Digital Signal Processing algorithms on real-time hardware systems. Students will develop DSP systems using C programming language on the ARM Cortex M processors. Prior knowledge of DSP is helpful but not required.

Prerequisite: Prior knowledge of programming using a higher-level programming (preferred C) language is required.

ETLS 677 SUSTAINABLE DEVELOPMENT STRATEGIES

Students will demonstrate understanding of the many environmental and social equity issues and solutions related to sustainable development. They will be given the tools such as: life cycle management, eco-efficiency, design for environment, etc. to propose solutions to issues. Students will learn about environmental controls, regulations, waste management, etc. and how they can be addressed. Through required outside reading, they will see both an industrial and environmental perspective of sustainable development. Prerequisites: None

ETLS 678 WEARABLE SYSTEMS DATA & IoT

Introduction to wearable sensor systems, applications, data analysis and IoT. Through this course, you will learn how to develop wearable platform for various different applications. Applications include, but not limited to, personal health monitoring, fitness, communication and assistive systems. Information collected from the wearable systems can be analyzed and expanded to an Internet of Things (IoT) applications to better implement health and wellness management systems. Through the course, we will also extend wearable applications and IoT technology to discuss smart homes and smart cities. Topics include: wearable sensors and systems, wearables applications, networking and communication, and data analysis via mobile (cloud) computing.

ETLS 679 EMBEDDED & CYBER PHYSICAL SYSTEMS

Design and development of embedded and cyber physical systems (CPS). System Architecture. Design Constraints. Internet of Things (IoT); Sensors; Wireless Communication: Bluetooth, Wi-fi, and ZigBee. Data Analysis techniques; Real-time Operating System (RTOS); Security and design challenges. Software development for embedded systems; Hardware and software design of a complete IoT network; CPS applications; Power considerations.

ETLS 699 SELECTED TOPICS

Manufacturing and leadership topics will be presented. (This course may be repeated for credit.)

ETLS Topics Courses

ETLS 701 DESIGN OF EXPERIMENTS

This course provides the student with a set of skills to improve products and processes already in manufacturing as well as to develop products and processes in the development stages of a project. The definition of DOE promoted is " a tool to assist in the process of understanding

the system". There will be discussion of how DOE fits into the overall product lifecycle and where it applies and does not apply to the area of testing. Tools covered include full and fractional factorials, central composite, Box-Behnken, Taguchi, Evolutionary Operation and the method of steepest ascent. Theoretical statistics understanding is assumed coming into the course. A standard, simple process will be presented which allows for improved communication and user confidence in using the tool set. The primary objective is to assist the student in implementing the skills learned as a part of the course. This is an applications - oriented course that includes case studies, team projects, student presentations and reports, guest lecturers and use of computational software. A quick statistical overview will be provided in the class as a refresher, but is not intended to cover the subjects in depth to students new to the subject. It would still be beneficial to review all of the topics prior to starting the class. The underlying statistics covered in ETLS 506 are a critical foundation for the material presented in the DOE class. The minimum background needs to include an understanding of: statistical symbology; normal distribution; ANOVA; and z, t, and F tests. General understanding of alpha and beta errors flow charts, Pareto charts, cause and effect diagrams and SPC is nice but not required. If you have equivalent background, the instructor will grant a written waiver.

ETLS 720 ANATOMY & PSYIOLOGY FOR MEDICAL DEVICES

The course teaches fundamentals of anatomy and physiology of nerves, muscle, heart, blood vessels, gastrointestinal system, urinary tract, liver and hormones. A broad range of disease states and medical devices are introduced to help students better relate to the anatomic and physiologic lecture information. Class experience also includes guest speakers and/or local hospital/clinic tours.

ETLS 721 MEDICAL DEVICE REGULATORY SUBMISSIONS

This course teaches the student about submissions for regulatory approval of medical devices. Topics include: medical device law, custom and research devices, significant and non-significant risk devices, FDA investigational device exemption, 510(k) substantial equivalence determination, pre-market approval, PMA supplements, third party review, combination devices, European economic area CE mark, international harmonization, MDR, device tracking, post market surveillance, and annual post approval reporting. Depending upon the degree of class interest medical device submissions in Canada, Australia and Japan may be covered.

ETLS 722 MEDICAL DEVICE QUALITY SYSTEMS

This class will focus on medical device quality system requirements for medical device manufacturers. The majority of class time will be spent reviewing the U.S. FDA Quality System Regulation with additional focus on the European Quality Standard for Medical Devices, ISO 13485, and the European Medical Device Regulation. The course includes a short overview on the history of FDA regulation, sources of U.S. law and regulated activities. Additional class topics include an introduction to the U.S. regulatory submission process, complaint handling, medical device event reporting, risk management, and corrections & removals. Several classes will include lecture and classroom discussion on how to handle FDA inspections, and the ramification of non-compliance discovered during inspections. Classroom methodology will be lectures with substantial student interaction encouraged. Coursework includes small group presentation and paper development as well as presentations of that work to the broader class.

ETLS 723 BIOMATERIALS & DESIGN MEDICAL DEVICES

This course will develop the necessary background to understand the material selection process in the design of medical devices. The students will learn about biomaterials and also develop an appreciation for the relationships between a material's properties, structure, and the implementation to achieve a desired functionality. The class is also suitable for students who do not have an extensive background in organic chemistry, biochemistry, or materials science. The first half of the semester will concentrate on the properties of several classes of materials including metals, polymers, ceramics, and composites. Topics such as material characterization, biocompatibility, processing of biomaterials, and failure of medical devices will be included in the second half. A number of existing medical devices and various real-life issues related to these devices will be explored based on instructor's experience of working in the industry. The course will be applications oriented, with particular emphasis on orthopedic and cardiovascular applications. This course will use a combination of lectures, guest lectures, tours, student presentations, and self-directed learning.

ETLS 724 MEDICAL DEVICE CLINICAL STUDIES

This course teaches clinical study design, research hypotheses, statistical considerations, clinical study planning and executions. Students are trained to apply this information to include clinical studies that encompass a wide variety of clinical objectives: prototype evaluation, pivotal studies, FDA approval requirements, marketing claims customer acceptance, reimbursement, etc. Other topics include data form design, databases, applicable U.S. and international regulations and selected topics of interest.

ETLS 731 FDA BIOLOGICS (COMBINATION PRODUCTS, DRUGS & BIOLOGICS)

This course gives an introduction to the submission approval process, validation, manufacturing and quality requirements for combination products, drugs

and biologics. Course topics will include a historic overview, the process to determine which FDA Center controls the regulatory process, applicable regulations and post-market approval practices for these products. Students will learn how the regulations and practices at CDER and CBER differ from CDRH. They will also learn how the FDA designated controlling center will shape the submission clearance/approval process, manufacturing control and post-market requirements for a combination product.

ETLS 734 CLINICAL EVIDENCE AND REIMBURSEMENT

Students will learn about the various types of clinical evidence, how clinical evidence is obtained and used and the broad requirements for clinical evidence. Students will learn the basic fundamentals of reimbursement, coding, coverage and payment. Students will gain an understanding on how these concepts impact the regulatory process and apply these fundamentals to strategic thinking through real-world case studies and examination of current healthcare issues.

ETLS 735 PRECLINICAL ACTIVITIES

Pre-clinical testing is utilized to evaluate the safety and potential efficacy of promising medical technologies prior to evaluation and use in human beings. This testing information is required by regulatory agencies around the world. The studies also provide extremely valuable and cost-effective product development opportunities for medical product sponsors. The tests are defined by guidance documents, international standards and the formal product risk assessment. Coordination of the multifunctional team that acquires and also utilizes this data can greatly enhance the value of this testing. This course will review the history and preclinical regulatory requirements of medical devices and description planning and management of associated pre-clinical evaluations.

In addition, the risks involved in medical device development and use are explored. Risk mitigation activities associated with development of an actual medical device are presented and then experienced through their application for a hypothetical medical

device. Class time is devoted to providing feedback for individual student projects about mitigating the development risks for a student chosen real or hypothetical medical device.

ETLS 737 INTERNATIONAL REGULATOR AFFAIRS FOR MEDICAL DEVICES

This class will provide a comprehensive understanding of global regulation for medical devices and the relationship between regulatory strategy and product development. It will include detailed discussion of medical device regulation in different geographies such as European Union (EU) nations, Japan, Canada, Australia, Latin America and Asia-pacific region. It will include discussion and case studies of the current global regulatory climate to help students develop practical applications/interpretation and enforcement of these regulations.

ETLS 738 INTERNATIONAL REGULATOR AFFAIRS FOR MEDICAL DEVICES: TEIR II

This class will provide a comprehensive understanding of regulation for medical devices in key Tier II countries (defined by FDA as those not in Tier I), and the relationship between regulatory strategy and product development. It will include detailed discussion of medical device regulation in identified geographies within Latin America, Asia-Pacific, and the Middle East. It will include discussion and case studies of the current respective regulatory climate to help students develop practical applications/interpretation and enforcement of these regulations.

ETLS 739 EV MARKET & TECHNOLOGIES

A one semester graduate course exploring the key areas of electric vehicle market and technologies. This course will provide an understanding of the present state of electric vehicle market and technologies, perspectives on the dynamics of the market and plenty of ideas on future opportunities. This course will

provide a solid foundation for anyone considering future career or business options with EVs and related technologies in this fast-growing field.

ETLS 744 POWER SYSTEMS & SMART GRIDS

An introduction to the practical aspects of power systems and the power grid. In one semester, this course will cover essential introductory concepts necessary to understand and use power systems as well as provide the foundation for more advanced power system study.

ETLS 745 POWER SYSTEMS OPERATIONS AND CONTROLS

This course is designed to provide students with an overview of Power Systems Operations and control. Certain areas like Automatic Generation Control, NERC Control Performance Standards and generation economics will be dealt with in some detail. Economic Dispatch, Unit Commitment and Optimal Power Flow concepts, theory and applications will also be covered. This course is designed for the graduate students in Electrical Engineering and upper level undergraduates.

Prerequisites: ETLS 744

ETLS 746 POWER ELECTRONICS

This one-semester course is designed to enable students to gain a thorough overview of power electronics at the graduate level. This power-electronics course will provide the foundation for more advanced study. The topics that will be covered include semiconductor switches and devices for power applications, converters, inverters, motor drive applications and introduction to power electronics application in power grid and renewable energy generation.

ETLS 747 ELECTRICAL MACHINES & VEHICLES

This course introduces the graduate student (or advanced undergraduate student) to the

principles and operation of electric machines common to the power industry. The course includes an introductory review of 3-phase power, magnetics and magnetic materials. These topics are followed by an in-depth study of real transformers (theory, operation, modeling, interconnection and application), synchronous machines, induction machines and power DC machines. The course concludes with an introduction to the power electronics, converters and inverters used in the control of electric machines.

ETLS 748 RENEWABLE ENERGY GENERATION

Energy is one of the most important issues of the century. This course will provide a basic understanding of various renewable and classical electric energy generation techniques. It will cover, among others, thermal, hydro, nuclear, solar, and wind-based power generation. We'll also review certain basic aspects of power storage and delivery. This course will help students in the evaluation and analysis of various energy systems in the context of technology, economics, and sustainability.

ETLS 750 SMART DISTRIBUTION SYSTEMS

The distribution portion of the grid is rapidly evolving in order to incorporate distributed energy resources (DERs) in an intelligent (smart), robust, resilient and sustainable manner. In addition, the transition from ICE based transportation to EVs will require significant improvements in the existing distribution system infrastructure. This one-semester course is designed to cover the design and operating principles of legacy distribution systems and lay a foundation for smart distribution systems. Prerequisite: ETLS 744

ETLS 753 POWER SYSTEM PROTECTION & RELAYS

This course covers the fundamentals of and the application of relays for power system protection. Topics in the course include: Power

System Philosophies, Types of Power System Protection, Faults, Symmetrical Components and Neutral Grounding , Fuses, Instrument Transformers, Relays – Types and Operating Principles, Circuit Breakers as well as Transmission Line Protection, Busbar Protection, Transformer Protection, Circuit Breaker Protection, Shunt Capacitor Protection, Shunt Reactor Protection, Generator Protection, Motor Protection, System Protection. Prerequisite: ETLS 744.

ETLS 770 AUTOMATED CONTROL MANUFACTURING PROCESS

An introduction to the key elements of control systems employed in manufacturing with examples from both batch and continuous-process applications. First, the fundamental theory of operation of closed loop (binary and analog) control systems is developed. Students will explore using PLCs to implement modern systems and become familiar with a PLC programming language. Second, the theory of operation and performance limits of sensors and actuators used in the industrial environment is explored. Some sensors to be considered measure position, speed, temperature, flowrate, level and force. Some actuators to be considered include pumps, hydraulic and pneumatic cylinders, heaters, valves, stepping motors, and AC and DC motors. Future trends in control systems targeted for the manufacturing plant will be presented. Students will demonstrate their ability to automate a manufacturing cell and quantify the cost impact of the project on the manufacturing example chosen in a term paper. Instructor's permission required for MS, MBA and Certificate students.

ETLS 771 MATERIALS ENGINEERING

This course introduces the student to theory and application of engineering materials. While particular emphasis is placed on traditional structural materials, emerging materials

technology is also discussed. Topics explore the physical and mechanical properties of metals, polymers, ceramics, and composite materials. Useful applications and limitations of those materials presented, and means of modifying their properties are discussed at length. Guest speakers and industrial tours supplement traditional learning by exposing the student to particular materials application, processing and evaluation.

ETLS 774 INTRODUCTION TO MECHATRONICS

This course provides an introduction to mechatronic systems that is useful to individuals managing the design or manufacture of such devices or as a foundation for further study in mechatronic design.

ETLS 777 FINITE ELEMENT ANALYSIS

This course offers an introduction to finite element analysis (FEA) in theory and practice. Students will learn the mathematical and physical foundation of the method, and will also be exposed to implementation via a commercial FEA program. Solution to real problems and projects will be integral parts of the course content and grade. Emphasis will be placed on the use of FEA for solid/structural mechanics problems, while the solution for thermal and fluid problems will be covered superficially. A strong background in mechanics of materials, physics and calculus is necessary. Knowledge of computer operating systems (windows or UNIX) and programming languages (FORTRAN, Basic, C) will be useful, but is not required.

ETLS 779 FEA IN MANUFACTURING

This course offers an introduction to finite element analysis (FEA) in theory and practice as applied in the manufacturing arena. Students will gain a foundation of the method and will be exposed to multiple FEA programs. An integral part of the course content will include solutions to real problems that are encountered by local manufacturing companies. Some topics which will be covered include structural mechanics,

machining, thermal analysis, and fluid dynamics. A strong background in mechanics of materials, physics, and manufacturing is necessary.

ETLS 789 SIMULATION & VISUALIZATION OF DYNAMIC SYSTEMS

Many engineering systems are inherently dynamic in nature. Characterizing and designing such systems requires mathematical modeling, simulation, and visualization using modern software such as MATLAB, SIMULINK, and SolidWorks, possibly with add-on modules. Lectures focus on the detailed applied mathematical modeling of a variety of systems from different energy domains with a bias towards mechanical systems such as mechanical translational, mechanical rotational, hydraulic, thermal, among others. The laboratory has 3 components to it: (1) software training (as necessary), (2) developing dynamic models using MATLAB and SIMULINK, (3) creating CAD models of systems, and (4) integrating the dynamics models with the visualization to create computer animations of the resulting motions of the mechanical systems. Students also work on a team-based dynamic simulation and visualization of mechanical systems project.

ETLS 810 ADVANCED CONTROLS

This class is a continuation of ENGR 410 - Control Systems and Automation. Topics include State Space Modeling, optimal controllers, Linear Quadratic Gaussian control and Kalman filters.

ETLS 851 ENTERPRISE INFORMATION SYSTEMS

This course examines the requirements and needs of companies and other organizations for operating information and, in particular, the capabilities of automated systems to manage, analyze and deliver this information. A review will be made of information system vendors that provide an integrated approach to information management including software features and equipment requirements. Systems that

provide these features are typically referred to as Enterprise Resource Planning (ERP) or Enterprise Resource Management (ERM) systems. The process and techniques of assessing, designing, evaluating, selecting and implementing enterprise information systems in order to develop and establish a repeatable organization methodology for this process is actively studied and applied.

The importance of process flow documentation and change management are studied in relation to successful enterprise information system implementation. Preparing requests for vendor proposals and analyzing vendor responses to choose a supplier are also studied. Topics include sales quotation and order processing, purchasing, manufacturing resource planning, shop floor control, inventory control, capacity planning, job shop and repetitive manufacturing, quality control, master scheduling, financial accounting and cost control, human resource management, logistics, engineering operations and E-commerce as they relate to automated information systems.

Prerequisites: ETL5 505 Managerial Accounting and Performance Management and ETL5 601 Program/Project/Team Management

ETLS 853 MANAGING INTELLECTUAL PROPERTY

An introduction to intellectual property concepts, focusing on patents, copyrights, trademarks, and trade secrets, and emphasizing their role in strategic management.

ETLS 855 IMPLEMENTING INNOVATION

The primary goal of this course is to assist the student in becoming an effective leader who makes innovation happen. Students will develop the ability to understand the innovation process and gain skills at leading an innovation project. The course objectives are to increase the students' ability to 1) think broadly like an executive 2) build allies and supporters 3) communicate with people from a broad range of backgrounds 4) become a better communicator and advocate for getting acceptance of new technology in

their company and 5) demonstrate courage and passion in a business setting.

The course will be conducted in a seminar format using readings, role-playing, presentations, video recording and individual and team practice. Everyone will be expected to be prepared and actively participate in each class session.

ETLS 858 ENGINEERING CAPSTONE

The Engineering Capstone course provides graduating Masters students with a long-term perspective on the rapidly-changing face of global industry and technology, and familiarizes class members with important concepts pertaining to developing company strategy and attaining company objectives. The course emphasizes personally understanding issues of leadership and ethics in a global environment, and the impact of technical considerations in the context of a global society. Students will integrate concepts and ideas from their previous coursework and experiences into a cohesive body of knowledge, building on an awareness of 21st Century issues. An intended deliverable is that each student will personalize "the right questions to ask" for lifelong learning. In so doing, they will continue to optimize their effectiveness in the challenging global economy of today and tomorrow. Prerequisite: To register, students must be within six credits of completing their degree (excepting the Capstone) and have no grades of Incomplete.

ETLS 880 REGULATORY SCIENCE PROJECT

Individual study of a research project appropriate to the student's program and mutually agreed upon by the faculty advisor, the student, and program director.

Prerequisite: Advisors consent

ETLS 881/882 ENGINEERING PROJECT CREDITS

Individual study, preparation of a report, and successful defense of an engineering project mutually agreed upon by the faculty advisor, the student, and

program director. Students are required to complete two consecutive semesters. Prerequisites: Faculty advisor and Program Director approval.

Graduate Programs in Software Course Catalog

SEIS 601 FOUNDATIONS OF JAVA I

[3 Credits]

Prerequisite: No previous programming experience in Java or any other programming language is required.

This is a foundational software development course focusing on fundamental programming concepts as implemented using the Java programming language. These concepts include general problem solving and algorithm creation techniques, primitive and object data types, constants, variables, expressions, and boolean logic and control flow. In addition, we will discuss fundamental object-oriented concepts, such as objects and classes, object instantiation and initialization, method implementation and invocation, interfaces, inheritance, and garbage collection. Students will apply these concepts by writing programs in the Java programming language. JUnit will be discussed for Unit and Integration Testing.

SEIS 602 FOUNDATIONS OF JAVA II

[3 Credits]

Prerequisite: SEIS 601 or an equivalent understanding of Foundational Software Development concepts and the ability to use and understand the Java programming language is required.

This is a foundational software development course focusing on intermediate-level fundamental and foundational concepts. Abstract data type concepts will be discussed in detail. Data Structures and some of their

associated algorithms for Algorithm Analysis will be discussed. Canonical implementations and framework supplied implementation alternatives (such as the JDK or other framework alternatives) will be explored and used as well. To apply the lecture concepts, we will implement software using the Java programming language and explore some of the tools used by software developers. Eclipse would be used as an integrated development environment for code development. Further, tools for managing software build, configuration, and version control (e.g., Git) and unit and integration testing (e.g., JUnit) will be used. We will also discuss multi-threading, memory management, refactoring, and advanced debugging techniques.

603 FOUNDATIONS OF PYTHON I

[3 Credits]

Prerequisite: No previous programming experience in Python or any other programming language is required.

This is an introductory software development course with a focus on fundamental and foundational concepts. These concepts include general problem solving and algorithm creation techniques, data types, constants, variables and expressions, boolean, control flow, and object-oriented concepts. Applying these concepts, we implement programs using the Python language. We will examine its use as an interpreted and a compiled language, working with data types such as numbers, strings, lists, dictionaries, and sets. Students will learn how to apply Python in managing data. PyTest will be discussed for Unit and Integration Testing.

604 FOUNDATIONS OF PYTHON II

[3 Credits]

Prerequisite: SEIS 603 or an equivalent understanding of foundational software

development concepts and the ability to use and understand the Python scripting language is required.

This is a foundational software development course focusing on intermediate-level fundamental and foundational concepts. Abstract data type concepts will be discussed in detail. Data Structures and some of their associated algorithms for Algorithm Analysis will be discussed. Canonical implementations and framework supplied implementation alternatives will be explored and used as well. To apply the lecture concepts, we will implement software using the Python programming language and explore some of the tools used by software developers. Spyder or PyCharm would be used as integrated development environments (IDE) for code development. Further, tools for managing software build, configuration, and version control (e.g., Git) and unit and integration testing (e.g., PyTest) will be used. We will also discuss multi-threading, memory management, refactoring, and advanced debugging techniques.

SEIS 605 TECHNICAL COMMUNICATIONS

[3 Credits]

Prerequisite: none

Must be taken by a student before exceeding 12 credits in Software Engineering, Software Management, and Information Technology majors in MS degree offered by Graduate Programs in Software. SEIS 605 is not a required course for MS in Data Science.

Teaches the fundamentals of written and oral communication as practiced by IT professionals. The course emphasizes product descriptions, instructions, informative and persuasive oral presentations, the role of graphics, and teamwork on projects. In addition, the course introduces managerial strategies and tactics, such as planning and evaluation, which

are critical for meeting an intended audience's needs. Recently, the scope of this course was expanded to include communication issues related to business analysis and project management. After completing this course, students will be more confident about their ability to communicate effectively in the workplace.

SEIS 610 SOFTWARE ENGINEERING

[3 Credits]

Prerequisite: seis 601 or seis 603. Seis 610 can be taken concurrently with seis 601 or seis 603

This introductory course covers software engineering concepts, techniques, and methodologies. The course introduces software engineering life-cycle models, such as scrum and kanban. Students learn the essential concepts of different lifecycle models and where their application is appropriate. The course continues by teaching concepts of requirements acquisition and various methods of requirements refinement. Also presented in this course are concepts of object-oriented and structured design. The course incorporates vital supporting topics such as software metrics, project planning, cost estimation, software maintenance, and an introduction to data structures and running time analysis.

SEIS 615 CLOUD COMPUTING

[3 Credits]

Prerequisite: SEIS 610. Students can take SEIS 610 concurrently.

This course covers the fundamentals of IT infrastructure in the cloud. It provides a detailed overview of cloud concepts, services, security, architecture, and economics. This course will examine the theory behind these modern practices and the real-world implementation challenges faced by IT organizations. Students will learn how to design and implement cloud-

based solutions. While the lessons will cover a number of theoretical concepts, we will primarily learn by doing. Students will gain hands-on experience with several widely adopted IT platforms including AWS and Docker.

SEIS 616 INFRASTRUCTURE AS CODE

[3 Credits]

Prerequisite: SEIS 615

This course covers the engineering and design of IT infrastructure, focusing on infrastructure as Code practices. IT infrastructure deployment practices are rapidly changing as organizations build infrastructure as code and adopt cloud computing platforms. We will examine the theory behind these modern practices and the real-world implementation challenges faced by IT organizations. The lessons will cover a number of tools, techniques, and patterns to implement infrastructure as code. Students will learn about platforms and tooling involved in creating and configuring infrastructure elements, patterns for using these tools, and practices for making infrastructure as code work in production.

622 WEB APP DEVELOPMENT

[3 Credits]

Prerequisite: SEIS 601 or SEIS 603

This course will teach students the essentials of becoming a full stack web developer by creating dynamic, interactive websites, and is suitable for anyone with basic computer programming skills. The course initially focuses on HTML, CSS and JavaScript and later transitions into technologies like Angular framework, Node, and Serverless functions in a cloud environment. Students develop skills for designing, publishing, and maintaining websites for professional or personal use. No previous experience or knowledge of web development is needed.

SEIS 625 SOFTWARE PROJECT MANAGEMENT (NOT AVAILABLE FOR MSS STUDENTS)

[3 Credits]

Prerequisite: SEIS 610

Students gain a management perspective and a development process for planning, estimating, and controlling software development. They learn to develop a well-defined plan before beginning any software development effort; how to handle changes during the execution of the plan; how to incorporate quality criteria in the development cycle; and how to use methods to keep the project on track. Included in the course is the use of project management software and simulation software in the development and control of the project plan. (If credit is received for this course students cannot receive credit for SEIS 621.)

SEIS 626 SOFTWARE QUALITY ASSURANCE/QUALITY CONTROL (NOT AVAILABLE FOR MSS STUDENTS)

[3 Credits]

Prerequisite: SEIS 625

This course builds on the project management process through the application of Software Quality Engineering concepts (Quality Assurance, Control and Testing). Students will work through a semester project in which they will think like a Software Quality Engineer. Practical tools and techniques will be applied toward the management and improvement of the quality of a software product and the development process. (If credit is received for this course, students cannot receive credit for SEIS 621.)

SEIS 627 SOFTWARE PLANNING AND DELIVERY MANAGEMENT

[3 Credits]

Prerequisite: SEIS 610

In the competitive technology market space, all organizations are working hard towards retaining and adding new customers. In light of

this objective, organizations continue to evolve in finding new ways to best manage and deliver their high quality software products to customers on time and within budget. SEIS-627 provides an introduction to different work management practices in software development. Topics covered in this course include traditional software development practices prescribed by PMI PMBOK as well as product management focusing on agile delivery practices. This course also includes hands-on projects to help students simulate real-world experiences as Project and Product Managers.

SEIS 630 DATABASE MANAGEMENT SYSTEMS AND DESIGN

[3 Credits]

Prerequisite: SEIS 610

This course focuses on database management system concepts, database design, and implementation. Conceptual data modeling using Entity Relationship (ER) is used to capture the requirements of a database design. Relational model concepts are introduced and mapping from ER to relational model is discussed. Logical database design (Normalization) and indexing strategies are also discussed to aide in system performance. Relational Algebra and Structured Query Language (SQL) are used to work with a database. From a system perspective, the course focuses on query optimization and execution strategies, concurrency control, locking, deadlocks, and database backup and recovery concepts. Database security and authorization are also discussed. Students will use Oracle and/or SQL Server to design a database and complete an application using SQL as their project.

SEIS 631 FOUNDATIONS OF DATA ANALYSIS

[3 Credits]

This course provides a broad introduction to the subject of data analysis by introducing common techniques that are essential for analyzing and deriving meaningful information from datasets. In

particular, the course will focus on relevant methods for performing data collection, representation, transformation, and data-driven decision making. The course will introduce students to Statistical Science including Probability Distribution, Sampling Distribution, Statistical Inference, and Significance Testing. Students will also develop proficiency in the widely used Python language which will be used throughout the course to reinforce the topics covered. Packages like NumPy and Pandas will be discussed at length for Data Cleaning, Data Wrangling: Joins, Combine, Data Reshape, Data Aggregation, Group Operation, and Time Series analysis. Prerequisite: SEIS 601 or SEIS 603 (may be taken concurrently).

SEIS 632 DATA ANALYTICS AND VISUALIZATION

[3 Credits] Prerequisite: None

The course provides an introduction to concepts and techniques used in field of data analytics and visualization. Data analytics is defined to be the science of examining raw data with the purpose of discovering knowledge by analyzing current and historical facts. Insights discovered from the data are then communicated using data visualization. Topics covered in the course include predictive analytics, pattern discovery, and best practices for creating effective data visualizations. Through practical application of the above topics, students will also develop proficiency in using analytics tools.

SEIS 635 SOFTWARE ANALYSIS & DESIGN

[3 Credits]

Prerequisite: SEIS 602 and SEIS 610

This course covers basic object-oriented techniques for specifying, designing, and implementing software systems. Iterative development methodologies are emphasized. The Unified Modeling Language (UML) is used as a notational system for capturing the development process artifacts. Students will gain experience with a software tool for creating UML diagrams. Other topics include use cases, class discovery and domain modeling, responsibility-driven design, basic design patterns, software class design,

converting designs to code, object-oriented testing, packaging, deployment, along with intermediate Java topics relevant to system implementation. This course also introduces ideas in functional and parallel programming. Students will work on an object-oriented team project, applying concepts and techniques to describe and create a working software system.

SEIS 636 REQUIREMENTS ANALYSIS

[3 Credits]

Prerequisite: SEIS 610. SEIS 636 may be taken concurrently with SEIS 610.

The objective of this course is to introduce the business analyst roles and responsibilities and knowledge areas such as enterprise analysis, requirements planning and measurement, requirements elicitation, requirements communication, requirements analysis and documentation, solution assessment and validation, business analysis fundamentals including tools and techniques.

SEIS 637 ENTERPRISE DATABASE MANAGEMENT SYSTEMS AND DESIGN

[3 Credits]

Prerequisite: SEIS 641

This course provides information about the functions of IBM's DB2, a relational database manager which may be installed under a variety of operating systems on many hardware platforms. DB2 runs under the z/OS, VM, Linux, UNIX, and Windows operating systems, to name a few. The course includes discussion of how the DB2 products provide services. The focus is on the services DB2 provides and how we work with DB2, not on its internal workings.

SEIS 638 ENTERPRISE TRANSACTION PROCESSING

[3 Credits]

Prerequisite: SEIS 604 and SEIS 641

In this comprehensive course, you will learn about all the concepts and facilities of IBM CICS Transaction Server V5.3. After completing this course, you will have the prerequisite knowledge for all of the follow-on CICS courses that IBM Training offers. This course provides a solid background in the transactions and application programming interfaces (APIs) that are supplied with CICS. You will learn about general guidelines and programming aids that support application development for CICS, including the features of CICSplex System Manager, working with the CICS Explorer graphical tools, how CICS protects its resources, and managing data integrity. You will also learn about the facilities that enable CICS to connect and communicate with other systems, and how to design and write CICS applications. Hands-on exercises throughout the course are designed to reinforce the lecture material and give you practical experience in working with the basics of CICS transaction processing and resource management. The exercises build skills in areas such as using the supplied transactions and the CICS Explorer, defining and managing CICS resources, CICS web services and interfaces, and debugging CICS applications.

SEIS 639 AI FOR HEALTHCARE

[3 Credits]

Prerequisite: SEIS 631

New Artificial Intelligence approaches provide powerful capability in analyzing complex and heterogeneous data that are previously difficult to analyze. The data may range from structural patient records to semi-structural medical text, images, and videos. Specifically, this course will discuss the following topics: (1) the fundamental learning methods used by machines, (2) problems, solutions, and advantages of artificial intelligence and machine learning, (3) learning and interpretation of healthcare and business data, (4) transferring existing artificial intelligence models for new business problems, (5) processing and classifying healthcare images such as X-ray or videos, (6) case study of time-series and text analytics in healthcare area and more general business domain. Data Science students completing

SEIS 764 Artificial Intelligence should not take this course.

SEIS 662 ENTERPRISE RESOURCE PLANNING

[3 Credits]

Prerequisite: SEIS 610

This course will provide a practical overview of Enterprise Resource Planning, connecting the academic and even marketing elements with real-world, case-based issues as encountered by business and other organizations. ERP has become a critical strategic consideration for many companies, and the course will look at best-practice implementations at leading companies internationally. Course will examine best practice usage of ERP in a global distributed computing environment. In addition, it will look into trends relating to critical issues such as Cloud and Big Data. Professionals currently working in the IT organizations or future IT professionals will benefit from this course.

SEIS 663 INFORMATION TECHNOLOGY SECURITY AND NETWORKING

[3 Credits]

Prerequisite: SEIS 610

This course will provide the foundation of information technology security, including authentication, authorization, access management, physical security, network security (firewalls, intrusion detection), application security (software and database), security regulations, and disaster recovery. We will explore social engineering and other human factors and the impact to security. There will be an emphasis on local area networking (LAN) and Internet architecture and protocols, including TCP/IP and the OSI layers. We study protocol details, the way they relate and interact with each other, and how they are applied in real systems.

SEIS 664 INFORMATION TECHNOLOGY DELIVERY

SEIS 732 DATA WAREHOUSING AND BUSINESS INTELLIGENCE

[3 Credits]

Prerequisite: SEIS 630

In order to build and maintain a successful data warehouse, it is important to understand all of its components and how they fit together. This course will cover data warehouse and data mart lifecycle phases while focusing on infrastructure, design, and management issues. The course project will provide an opportunity to for hands-on experience with some of the available tools and technologies. Topics include: differences between data warehouses and traditional database systems (OLTP), multidimensional analysis and design, building data warehouses using "cube" vs. RDBMS (Star schema, etc.), planning for data warehouses, extraction transformation and loading (ETL), online analytical processing (OLAP), data mining, quality and cleansing, common pitfalls to avoid when designing, implementing and maintaining data warehouse environments, and the impact of new technologies (data web house, clickstream, XML).

SEIS 733 DATABASE ADMINISTRATION CONCEPTS

[3 Credits]

Prerequisite: SEIS 630

Database Administrators (DBA's) have to perform multiple functions within an organization. This class focuses on the issues that database administrators have to deal with in their everyday professional life. Responsibilities of a DBA are broken down by functions and each function is studied. These include: database system planning, database system installation and upgrading, database design (conceptual, logical, and physical), normalization (de-normalization), database loading and unloading, database change management, data availability, database security and access management, performance management (query processing, indexing, physical space planning, etc.), system

performance, data integrity, data and storage management, data migration, data movement and distribution, database connectivity, fault tolerance (back ups and recovery) and disaster recovery planning. Students will use SQL Server and Oracle to design, implement and administer their database using these two commercial products. Although the course uses examples of these two product functions, it is not a SQL Server or Oracle DBA certification course.

SEIS 735 HEALTHCARE ANALYTICS

[3 Credits]

Prerequisites: SEIS 632 OR SEIS 734 OR SEIS 763

We can keep improving the quality and safety of health care if the rapid growth of medical knowledge and medical data can be efficiently analyzed and effectively shared.

This course will discuss processes in healthcare analytics, including data acquisition, storage, retrieval, management, and analysis of healthcare data in heterogeneous formats (i.e. numeric health records, medical text, and medical images).

Major topics include: (1) analyzing patient records and identifying frequent medical sequences for treatment and prevention, (2) evaluating medical text and generating aggregated summary based on hierarchical medical concepts, (3) retrieving information from different types of medical images, (4) building clinic decision support systems to detect possible medical mistakes, and (5) comparing brain connectivity graphs from patients with different neurological conditions. Amazon Cloud will be used to analyze multi-million records of numeric and text data.

SEIS 736 BIG DATA ARCHITECTURE

[3 Credits]

Prerequisites: (SEIS 601 or SEIS 603) and SEIS 630. May take concurrently with SEIS 737.

As data is becoming more and more ubiquitous, the need to consume it to perform computations and power intelligent systems is also becoming more important. Bigger and more powerful neural networks need a large amount of data to be more accurate in performing tasks and making decisions. This means that it is increasingly important to understand the architecture and data plumbing for such sophisticated systems of the future. This course provides a broad coverage of the building blocks of a modern big data architecture which is fast, scalable and reliable. Major topics covered in this course include: (1) persistent storage and data organization (2) data ingestion and integration, (3) batch and stream processing, (4) modern cloud architectures, and (5) a real-life example of geospatial analytics using such architecture. Students will complete hands on exercises leveraging big data tools to build data pipelines.

SEIS 737 BIG DATA MANAGEMENT

[3 Credits]

Prerequisites: SEIS 630

This course covers the technical concepts of managing vast amount of unstructured, semi-structured and structured data, collectively called "Big Data". Due to the sheer volume of Big Data, traditional approaches to managing databases does not work well for Big data and does not perform as expected. A distributed architecture for both the file system and the operating system is needed. Some of the techniques used in managing Big Data have the origins in the research and the developments that have been going on for decades in the area of parallel processing and distributed database management systems.

This course focuses on why big data sets must be distributed and the issues that distribution introduces. The basic concepts on which distributed data sets are handled are discussed first. Once a foundation is defined, software tools that we use to work with big data sets are studied to provide an in-depth analysis of the concepts introduced.

Specifically, we will study the issues of distributed data design, data fragmentation, data replication, and distributed fault tolerance/recovery. We will also study the use of Hadoop, Pig, Hive, HBase, MongoDB, and Neo4j in dealing with big data sets for real life examples. We will use open source software for these tools in class.

SEIS 738 DATA SCIENCE PROJECT

[3 Credits]

Prerequisites: SEIS 736 or SEIS 737 or SEIS 763 or SEIS 764

MS in Data Science students may choose to register for SEIS 738 and complete a research or software development project related to Data Science area under the supervision of a full-time GPS faculty member.

SEIS 739 SOFTWARE ANALYSIS, DESIGN, AND IMPLEMENTATION

[3 Credits]

Prerequisite: SEIS 601 and SEIS 610

The course is a unique culmination of software development practices taught in the Master of Software Engineering program and provides students an opportunity to create and showcase a capstone project by implementing a full-stack application. This capstone class provides Software Engineering students with the unique opportunity to conceptualize, design, and implement a project related to their chosen domain. During the project, students build competence in a modern interactive and incremental development methodology; students will refine their acquisition skills and analysis of program requirements. Students will also learn software design patterns and create sophisticated architectural and operational diagrams. Automated software tests will be run, and continuous integration deployment principles will be performed.

SEIS 740 REAL-TIME SYSTEMS AND APPLICATIONS

SEIS 743 COMPUTER ARCHITECTURE

[3 Credits]

Prerequisite: SEIS 610

Computers have changed fundamentally during recent years. The performance of software systems is dramatically affected by how well software designers understand the basic hardware techniques at work in a system. The objective of this course is to provide a firm grounding in principles and techniques to all software engineers including compiler writers, operating systems designers, database programmers, and real-time systems programmers. The course will show relationship between hardware and software and will focus on the concepts that are the basis for modern computers. This course will cover performance issues, instruction set design, processor implementation techniques, pipelining, parallel processing, vector processing, and memory hierarchy including cache memory, input/output factors, RISC architecture, and multiprocessors.

SEIS 744 IoT WITH MACHINE LEARNING

[3 Credits]

New Prerequisite: SEIS 601 or SEIS 603 or an equivalent understanding of foundational programming concepts.

This course is designed for students to be exposed to technologies and best practices that help them understand both the high-level concepts at a systems level and the supporting technologies that make up the combination of Machine Learning and the Internet of Things. TinyML, short for Tiny Machine Learning is a fast-growing field of Machine Learning technologies that are able to run on-device sensor data analytics using extremely low power. Improvements in optimization algorithms and frameworks for running inferences at the edge, it is now possible to make IoT devices smarter. Students will get to

build a rapid prototype of a real product and put it into practice to collect and analyze data to make predictions. The course will provide a foundation on capturing data from the physical world and applying Machine Learning techniques to gain predictions and insights at the edge.

SEIS 751 WEB APPLICATION DESIGN AND DEVELOPMENT

[3 Credits]

Prerequisite: SEIS 610.

This course introduces the fundamentals of web application design, and development using open standards. Students will learn how to create interactive database-driven media rich web applications. Students will learn both the technical and design aspects of creating effective web applications using a variety of technologies and development tools (mostly open source tools where appropriate). The course culminates in a term project that brings together elements of design and technology into a functioning web application. This is an introductory course and no prior knowledge or experience of web design or web development is required.

SEIS 763 MACHINE LEARNING

[3 Credits]

Prerequisite: SEIS 631 and SEIS 632. Students can take SEIS 632 concurrently with SEIS 763.

Machine Learning builds computational systems that learn from and adapt to the data presented to them. It has become one of the essential pillars in information technology today and provides a basis for several applications we use daily in diverse domains such as engineering, medicine, finance, and commerce. This course covers widely used supervised and unsupervised machine learning algorithms used in industry in technical depth, discussing both the theoretical underpinnings of machine learning techniques and providing hands-on experience in

implementing them. Additionally, students will also learn to evaluate effectiveness and avoid common pitfalls in applying machine learning to a given problem.

SEIS 764 ARTIFICIAL INTELLIGENCE

[3 Credits]

Prerequisite: SEIS 763

Artificial Intelligence has made significant strides in recent times and has become ubiquitous in the modern world, impacting our lives in different ways. By harnessing the power of deep neural networks, it is now possible to build real-world intelligent applications that outperform human precision in certain tasks. This course provides a broad coverage of AI techniques with a focus on industry application. Major topics covered in this course include: (1) how deep neural networks learn their intelligence, (2) self-learning from raw data, (3) common training problems and solutions, (4) transferring learning from existing AI systems, (5) training AI systems for machine visions with high accuracy, and (6) training time-series AI systems for recognizing sequential patterns.

Students will have hands-on exercises for building efficient AI systems.

SEIS 770 OBJECT-ORIENTED PATTERNS AND ARCHITECTURES

[3 Credits]

Prerequisite: SEIS635.

This course introduces students to using object-oriented architecture and design patterns in the development of high quality, reliable software systems. Patterns and architectures can have a significant effect on the time to deliver systems and the maintainability and quality of systems. Current object-oriented development methods and tools will be used to describe and implement software designs that are based on patterns. Students will learn the abstraction skills required to discover, document, and patterns and architectures. Java will be used.

SEIS 771 ADVANCED OBJECT CONCEPTS AND ISSU

[3 Credits]

Prerequisite: SEIS 635 required; SEIS 770 highly recommended

This course gives students first-hand experience in applying object-oriented software development best practices in a realistic software development environment. In the process of doing this, students learn and apply advanced object-oriented software development concepts and approaches including agile software development processes, pattern-based design and development, refactoring to maintain system design quality, distributed object computing in an enterprise level software architecture environment, and the use of relational database management systems by object-oriented systems.

SEIS 776 PROJECT I

[3 Credits]

Prerequisite: SEIS 627 and permission of the department

Available to Software Engineering, Software Management and Information Technology students. These students may choose to register for SEIS776-777 and complete a research or software development project under the supervision of a full-time GPS faculty member. Students cannot receive credit for SEIS 776 without completing SEIS 777.

SEIS 777 - PROJECT II

[3 Credits]

Prerequisite: SEIS 776

Available to Software Engineering, Software Management and Information Technology students. These students may choose to register for SEIS776-777 and complete a research or software development project under the supervision of a full-time GPS faculty member. Students cannot receive credit for SEIS 776 without completing SEIS 777.

SEIS 779 INTERNSHIP

[0 Credits]

This zero-credit course is for the curricular practical training for international students.

SEIS 780 - 783 SEMINARS

(Not available for MSS students) Credits: variable

Prerequisites: variable

Students may take a seminar in lieu of an elective. Seminars are designed to provide the student with in-depth topical knowledge and expertise for a subject area of interest to a faculty member or a group of Graduate Programs in Software students.

SEIS 785 - 789 TOPICS

Credits: variable Prerequisites: variable

Current GPS Topics Course Listings and Descriptions

SEIS 790 AND SEIS 795 RESEARCH, INDEPENDENT STUDY

Credits: variable Prerequisites: variable