2024-2025

GRADUATE ENGINEERING & DEPARTMENT OF SOFTWARE ENGINEERING & DATA SCIENCE HANDBOOK & CATALOG

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Assistant Directors of Academic Operations

*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

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 employment, educational policies, admissions policies, scholarship and loan programs and all other educational programs and activities.

University of St. Thomas Mission, Convictions 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, value-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.

Department of Software Engineering and Data Science Mission, Vision, and Values

Mission

Graduate Programs in Software is committed to providing 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. Learn more about our Board of Governors and its members.

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. Learn more about our External Advisory Board and its members.

Department of Software Engineering & Data Science Strategic Advisory Board

The Strategic Advisory Board provides strategic advice and counsel to the Department of Software Engineering & Data Science 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 Department of Software Engineering & Data Science 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. Learn more about our Strategic Advisory Board and its members.

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 Student 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. Learn more about the Office of International students & Scholars.

Conditional Acceptance

Applicants who have one or more admission requirements in progress (e.g., completing an English proficiency or a pending U.S. undergraduate degree) may be conditionally admitted. If the applicant does not meet the conditions of acceptance prior to the start of the semester of intention, 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 acceptance. Failure to meet the conditions of provision can result in program dismissal.

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 higher, 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 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).

Courses in the School of Engineering Graduate Catalog that are delivered through a professional development offering are available for credit by examination.

To receive credit, the student should receive a passing score equivalent to a grade of C on the examination.

A 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

Students can find their assigned advisor by visiting Murphy Online.

Advisors are available by appointment or during 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 accounts 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 accommodation 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.

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

Waitlists

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 and the seat will be offered to the next student on 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 24 hours, their name will be removed from the waitlist and the seat will be offered to the next student on 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 Period

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 semester dates & deadlines page.

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 their transcript.

Course Load

It is recommended that a student working full-time enroll in no more than two graduate courses during the spring and fall semesters, and one course per 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 a Course

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.

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 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. All payment questions should be directed to the Business Office at 651-962-6600.

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 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.

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.

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 the 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.

Exams

Exam Proctoring Policy

The University of St. Thomas continues to strive for academic excellence and integrity in times of continuous technological advancement. The University has selected Honorlock, an exam monitoring tool to assist in academic integrity in the online testing environment. This is part of a three-step approach of prevention, detection, and communication. By registering for a course within the School of Engineering's Graduate Programs, students are agreeing to install the tools on exam-taking devices for the duration of any course exam, if required by the faculty instructor.

If a student fails to maintain academic integrity or violates the exam proctoring policy, send an email to soegradservices@stthomas.edu identifying:

- Student name/ID number
- Course number/instructor
- Date of infraction
- Detailed infraction description; include evidence (if feasible).
- Communication to student

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.

Academic Conduct, Probation and Integrity

Code of Conduct for Graduate Students

The University of St. Thomas and the School of Engineering expects members of its community to act responsibly and appropriately at all times, both on and off campus. Students are subject to disciplinary sanctions for conduct that is detrimental or disruptive to the mission and convictions of the University and the School of Engineering. Students who disrupt the classroom will be asked to modify their behavior and may be asked to leave the course. The graduate program reserves the right to escalate any conduct incident to the Dean of Students Office. A program designee and the Assistant Dean of Students will process the student conduct incident together. If an incident is escalated to the Dean of Students Office, the Program Director and the Assistant Dean of Students will notify the student to process the conduct issue.

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 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.

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 complete all academic work on their own. Academic integrity is required in the School of Engineering at the University of St. Thomas.

Students are required to complete/submit all academic work as one's own. If a student fails to do so, a grade of zero is issued. If the student commits a second academic integrity violation in the same or future course, a course grade of "F" is issued. If a third violation occurs, the student is dismissed from the program.

Common forms of academic integrity violations 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 Integrity Violations: Knowingly helping or attempting to help another student commit academic integrity violation.
- 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.

Students are expected to do their own work on all academic assignments, tests, projects and papers. Academic integrity violations will not be tolerated at the University of St. Thomas. Students are encouraged to report incidents of academic integrity violations to course instructors or the Associate Dean.

Violations

Common forms of academic integrity violations 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 Integrity Violations: Knowingly helping or attempting to help another student commit academic integrity violations.
- 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/resourcesforstu dents/.

When academic integrity violations occur, the following procedures will be followed:

Instructor's Actions

When an incident of academic integrity violation 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 integrity violation 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 integrity violation, 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 from 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.

The full Tobacco Free Campus policy can be found here.

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, Certificate or Micro-Credential

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

Students may add one certificate to their degree program. The certificate is required to be completed before or at the time the master's 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. Certificates not completed prior to the degree requirements being met will be removed from the student's record upon graduation.

Students may add one micro-credential to their degree program. The micro-credential is required to be completed before or at the time the master's degree requirements are met. If the micro-credential requirements are met prior to the degree requirements, the micro-credential will be awarded in the term of completion. Micro-credentials not completed prior to the degree requirements being met will be removed from the students record upon graduation.

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.
- Students must maintain 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.

Department of Software Engineering and Data Science

Master's in Artificial Intelligence

The M.S. in Artificial Intelligence equips students with the expertise to design and develop cutting-edge AI systems. Through this program, students learn advanced machine learning techniques, natural language processing, computer vision, and reinforcement learning, gaining proficiency in algorithm development and model optimization. They also acquire skills in data preprocessing, ethical AI implementation, and a deep understanding of AI's societal impact, preparing them for impactful careers in research, industry, or entrepreneurship in the rapidly evolving field of artificial intelligence.

To complete the requirements for the MS in Artificial Intelligence, students must successfully complete 10 courses (30 graduate semester credits) and with a GPA of at least 2.7.

Choose one elective or an approved independent study (or two electives if SEIS 603 is waived) from any course listed in the Department of Software Engineering & Data Science 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 software Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses and Electives

Ten Required Courses:

- SEIS 603 Foundations of Python I
- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 651 AI Ethics
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- SEIS 765 MLOps
- SEIS 766 Vision AI
- SEIS 767 Conversational AI
- SEIS 795 Independent Study OR one SEIS Approved Elective (see below)

Approved Electives:

- SEIS 615 Cloud Computing
- SEIS 622 Web App Development
- SEIS 630 Database Management Systems and Design
- SEIS 663 Introduction to Cybersecurity
- SEIS 732* Data Stores and Feature Design (*only for students with database

backgrounds)
- SEIS 745* Data Lake Engineering (*only for students with database backgrounds)
- SEIS 795 Independent Study

View course descriptions listed in the Graduate Programs in Software (SEIS) course catalog.

Masters in Data Science

The M.S. 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 MS in Data Science, students must successfully complete 10 courses (30 graduate semester credits) and with a GPA of at least 2.7.

Choose one elective (or two electives if SEIS 603 is waived) from any course listed in the Department of Software Engineering & Data Science 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 software Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses and Electives

Nine Required Courses:

- SEIS 603 Foundations of Python I
- SEIS 615 Cloud Computing
- SEIS 630 Database Management Systems and Design
- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 732 Data Stores and Feature Design
- SEIS 745 Data Lake Engineering
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- One Elective: Choose one SEIS elective from any course listed in the Graduate Programs in Software course catalog.

View course descriptions listed in the Graduate Programs in Software (SEIS) course catalog.

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. 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 MS in Information Technology, students must successfully complete 10 graduate courses (30 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.

Electives:

Choose two electives (or three electives if SEIS 603 is waived) from the Department of Software Engineering & Data Science (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 software Master of Science degree. The transfer courses must have been taken at the graduate level. The transfer school must be regionally accredited.

Required Courses and Electives

Eight Required Courses:

- SEIS 603 Foundations of Python I
- SEIS 709 Enterprise Architecture & Strategy
- SEIS 627 Software Agile Processes
- SEIS 615 Cloud Computing
- SEIS 616 Infrastructure as Code
- SEIS 630 Database Management Systems and Design
- SEIS 632 Data Analytics and Visualization
- SEIS 663 IT Security and Networking
- Two Electives: Choose two electives from any course listed in the Graduate Programs in Software course catalog.

View course descriptions listed in the Graduate Programs in Software (SEIS) course catalog.

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 10 courses (30 graduate semester credits) and maintain a GPA of 2.7.

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 and Electives

Eight Required Courses:

- SEIS 601 Foundations of Java I
- SEIS 602 Foundations of Java II
- SEIS 610 Software Engineering
- SEIS 615 Cloud Computing
- SEIS 622 Web App Development
- SEIS 616 Infrastructure as Code
- SEIS 630 Database Management Systems and Design
- SEIS 739 Software Analysis, Design and Implementation
- Two Electives: Choose two electives from any course listed in the Graduate Programs in Software course catalog.

View course descriptions listed in the Graduate Programs in Software (SEIS) course catalog.

Department of Software Engineering and Data Science Certificates

The University of St. Thomas Department of Software Engineering & Data Science 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 on 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.

Graduate Certificate in Applied Artificial Intelligence

The Graduate Certificate in Applied AI is specifically designed for professionals aiming to broaden their expertise in the latest artificial intelligence technologies. This advanced program expects participants to come with a prior background in machine learning and AI, leading them into more specialized territories such as Generative AI, ML Ops, and AI Ethics. It is ideal for individuals who already have experience in the AI field and are looking to substantially enhance their abilities and understanding of recent developments and ethical practices in AI technology.

Students have the option to use the coursework from their graduate certificate to continue in a Master of Science degree program offered by the Department of Software Engineering & Data Science..

To complete the Graduate Certificate in Applied Artificial Intelligence, four SEIS graduate courses (12 graduate semester credits) are required with a GPA of 2.7 or higher. Students are expected to have a prior background in Machine Learning and Artificial Intelligence:

Four required courses:

- SEIS 651 AI Ethics
- SEIS 765 ML Ops
- SEIS 766 Vision AI
- SEIS 767 Conversational AI

View the Graduate Programs in Software course catalog.

Graduate Certificate in Artificial Intelligence Foundations

Our Graduate Certificate in AI Foundations. This certificate provides a foundational understanding of artificial intelligence, exploring essential principles, algorithms, and their practical applications. Students will gain a comprehensive grasp of AI theories and methodologies, equipping them to navigate and contribute to the ever-evolving field of artificial intelligence.

Students have the option to use the coursework from their graduate certificate to continue in a Master of Science degree program offered by the Department of Software Engineering & Data Science.

To complete the Graduate Certificate in AI Foundations, you must complete the following four required SEIS graduate courses (12 graduate semester credits) with a GPA of 2.7 or higher. Students will be expected to have a prior background in Python or take SEIS 603 Foundations of Python I.

Four Required Courses:

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

View the Graduate Programs in Software course catalog.

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, you must complete the following four courses (12 graduate semester credits) with a GPA of 2.7 or better. Students will be expected to have a prior background in Python or take SEIS 603 Foundations of Python I:

Four Required Courses:

- SEIS 630 Database Management Systems and Design
- SEIS 631 Data Preparation and Analysis
- SEIS 732 Data Stores and Feature Design
- SEIS 745 Data Lake Engineering

View the Graduate Programs in Software course catalog.

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, you must complete the following four courses (12 graduate semester credits) with at a GPA of 2.7 or better:

Four Required Courses:

- SEIS 601 Foundations of Java I or SEIS 603 Foundations of Python I
- SEIS 610 Software Engineering
- SEIS 630 Database Management Systems and Design
- SEIS 627 Software Agile Processes

View the Graduate Programs in Software course catalog.

Graduate Certificate in Cybersecurity

A strong cybersecurity workforce is a requirement for all organizations operating in the digital world. As risks evolve, demand will continue to grow in this ever-changing field. Whether it is on the front lines stopping attacks, or managing technical risk at an enterprise level, the Graduate Certificate in Cybersecurity prepares technology professionals to meet this demand.

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.

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.

To complete the Graduate Certificate in Cybersecurity, you must complete the following four required SEIS graduate courses (12 graduate semester credits) with a GPA of 2.7 or higher. Please note: Students in the Graduate Certificate in Cybersecurity must demonstrate adequate proficiency in a programming language (Java or Python) before enrolling in the program. Students will be expected to have a prior background in Java or Python programming language, or take SEIS 601 Foundations of Java I or SEIS 603 Foundations of Python I:

Four Required Courses:

- SEIS 640 Ethical Hacking and Operating Systems
- SEIS 663 Introduction to Cybersecurity
- SEIS 715 Networking Architecture and Protocols
- SEIS 723 Security Operations

View the Graduate Programs in Software course catalog.

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.

To complete the Graduate Certificate in Data Analytics, you must complete the following four courses (12 graduate semester credits) with at a GPA of 2.7 or better:

Four 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

View the Graduate Programs in Software course catalog.

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 Digital Transformation, you must complete the following four courses (12 graduate semester credits) with a GPA of 2.7 or better. Students will be expected to have a prior background in Python or take SEIS 603 Foundations of Python I:

Four Required Courses:

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

View the Graduate Programs in Software course catalog.

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.

To complete the Graduate Certificate in Full Stack Development, you must complete the following five courses (15 graduate semester credits) with at a GPA of 2.7 or better:

Five Required Courses:

- SEIS 601 Foundations of Java I (or SEIS 603 Foundations of Python I)
- SEIS 602 Foundations of Java II (or SEIS 604 Foundations of Python II)
- SEIS 610 Software Engineering
- SEIS 622 Web App Development
- SEIS 630 Database Management Systems & Design

View the Graduate Programs in Software course catalog.

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 four graduate courses (12 graduate semester credits) with 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.

To complete the Graduate Certificate in Healthcare AI, you must complete the following four courses (12 graduate semester credits) with at a GPA of 2.7 or better:

Four Required Courses:

- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization
- SEIS 639 Machine Learning for Healthcare
- SEIS 735 AI Case Study for Healthcare

View the Graduate Programs in Software course catalog.

Please note: Students in the Graduate Certificate in Healthcare AI must demonstrate adequate proficiency in SQL or take SEIS 630 Database Management Systems and Design before enrolling. Students will be expected to have a prior background in Python or take SEIS 603 Foundations of Python I.

Post–Masters Advanced Study Certificate

This certificate is available to software professionals who have already obtained a master's degree. The program offers an opportunity for individuals to enhance their expertise through an individually designed course of study.

A master's degree is required in software, computer science, information technology, or an equivalent field from a regionally accredited educational institution in the U.S. (or international equivalent) with an overall grade-point-average (GPA) of at least 2.7

To complete the Graduate Certificate of Advanced Study you must complete five graduate software courses with a GPA of 2.7 or better. Courses from a previous master's degree cannot be applied toward the Graduate Certificate of Advanced Study.

Please note: You may choose any five courses in the Graduate Programs in Software course catalog.

Micro-Credentials

Graduate Micro-Credential in Digital Product Management

With the accelerated pace of technology and interconnectedness of devices, the product economy is rapidly growing and becoming more complex. Students in the Graduate Micro-Credential in Digital Product Management will learn how to oversee and guide the development, launch, and growth of digital products, ensuring that they align with customer needs and business objectives.

Our graduate-level micro-credentials are practical and industry-relevant and offer a way to gain expertise quickly in an ever-changing landscape and realize a competitive edge.

In just two classes, you will earn a micro-credential and digital badge to bolster your resume and online profile. Badges are a convenient way to digitally showcase and share expertise and help differentiate yourself in the market.

Students have the option to use coursework from the graduate micro-credential program to continue in a graduate certificate or master's degree program offered by Graduate Programs in Software.

To complete the Digital Product Management micro-credential, you must complete the following two required SEIS graduate courses (6 graduate semester credits) with a GPA of 2.7 or higher:

Two Required Courses:

- SEIS 627 Software Agile Processes
- SEIS 628 Digital Product Management

View the Graduate Programs in Software course catalog.

Graduate Micro-Credential in Distributed Ledger Technologies

Distributed ledger technology (DLT) is a way of storing and updating data across a networked database and is becoming necessary in modern businesses and enterprises that need to ensure accuracy in financial reporting, manage supply chains, prevent fraud, and identify inefficiencies. Students in the Graduate Micro-Credential in Distributed Ledger Technologies will gain knowledge in the infrastructure and protocols and hands-on experience in areas such as programming, cryptography, blockchain technology and smart contracts.

Our graduate-level micro-credentials are practical and industry-relevant and offer a way to gain expertise quickly in an ever-changing landscape and realize a competitive edge.

In just two classes, you will earn a micro-credential and digital badge to bolster your resume and online profile. Badges are a convenient way to digitally showcase and share expertise and help differentiate yourself in the market.

Students have the option to use coursework from the graduate micro-credential to continue in a graduate certificate or master's degree program offered by Graduate Programs in Software.

To complete the Graduate Micro-Credential in Distributed Ledger Technologies, you must complete the following two courses (6 graduate semester credits) with at a GPA of 2.7 or better:

Two Required Courses:

- SEIS 710 Blockchain
- SEIS 711 Smart Contracts

View the Graduate Programs in Software course catalog.

Graduate Micro-Credential in Information Security & Risk

Strong growth in the field of information security and risk management reflects the high demand for protecting the confidentiality, integrity, and availability of information in this increasingly tech-driven world. Addressing security concerns with public cloud, software as a service, growing automation and adoption of AI technologies is crucial for business operations.

Students in the Graduate Micro-Credential in Information Security and Risk will gain a foundational understanding of information technology security, including authentication, authorization, access management, physical security, network and application security, and digital privacy, as well as explore IT governance, risk, and compliance in depth.

Our graduate-level micro-credentials are practical and industry-relevant and offer a way to gain expertise quickly in an ever-changing landscape and realize a competitive edge. In just two classes, you will earn a micro-credential and digital badge to bolster your resume and online profile. Badges are a convenient way to digitally showcase and share expertise and help differentiate yourself in the market.

Students have the option to use coursework from the graduate micro-credential to continue in a graduate certificate or master's degree program offered by Graduate Programs in Software.

To complete the Information Security and Risk Micro-credential, you must complete the following two courses (6 graduate semester credits) with at a GPA of 2.7 or better:

Two Required Courses:

- SEIS 663 Introduction to Cybersecurity
- SEIS 670 IT Governance, Risk and Compliance

View the Graduate Programs in Software course catalog.

Graduate Micro-Credential in Manufacturing AI

For manufacturers, artificial intelligence (AI) can be a game changer, offering a competitive advantage by

using machine learning (ML) solutions and deep learning neural networks to optimize manufacturing processes with improved data analysis and decision-making. Students in the Graduate Micro-Credential in Manufacturing AI will gain foundational knowledge of Smart Manufacturing (SM) and AI concepts necessary to build any SM system, as well as learn data handling and simulation techniques used in the manufacturing industry.

Our graduate-level micro-credentials are practical and industry-relevant and offer a way to gain expertise quickly in an ever-changing landscape and realize a competitive edge.

In just two classes, you will earn a micro-credential and digital badge to bolster your resume and online profile. Badges are a convenient way to digitally showcase and share expertise and help differentiate yourself in the market.

Students have the option to use coursework from the micro-credential to continue in a graduate certificate or master's degree program offered by Graduate Programs in Software.

To complete the Graduate Micro-Credential in Manufacturing AI, you must complete the following two courses (6 graduate semester credits) with a GPA of 2.7 or higher.

Two Required Courses:

- SEIS 756 AI for Smart Manufacturing I
- SEIS 757 AI for Smart Manufacturing II

View the Graduate Programs in Software course catalog.

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 30 graduate 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, Electrification and Sustainability, Embedded and Intelligent Systems, and Circuits, Signals and Systems.

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 or 30 credits

Choose one concentration:

- Power Systems
- Electrification and Sustainability
- Embedded and Intelligent Systems
- Circuits, Signals and Systems

The Power Systems concentration emphasizes the study and control of power systems, Microgrids, 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 from one form to another with near 100% efficiency. Microgrids improve the reliability and resiliency of the power grid.

Choose six courses or more (18 graduate credits or more) from the list below:

- ETLS 744 Power Systems and Smart Grids
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines and Vehicles
- ETLS 748 Renewable Energy Generation
- ETLS 753 Power System Protection and Relay
- ETLS 756 Discrete Control of Power Electronics
- ETLS 757 Microgrids
- ETLS 810 Advanced Controls

Technical Electives (up to 4 graduate courses or 12 credits):

Choose technical electives from course list below:

- ETLS 745 Power Systems Operations and Controls
- ETLS 754 Electrification
- ETLS 758 Grid Modernization
- ETLS 739 EV Market and Technologies
- ETLS 611 Introduction to Sustainability
- ETLS 612 Sustainability Verification
- ETLS 620 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 Applications of AI in Engineering
- ETLS 679 Embedded & Cyber-Physical Systems
- ETLS 681 AI, Robotics & Autonomous Systems
- ETLS 683 Electronic Design of Implantable Medical Devices
- ETLS 684 PCB Engineering and Design
- ETLS 699 Selected Topics
- SEIS 663 Introduction to Cybersecurity
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLS 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

*Other electives approved by the Program Director.

The Electrification and Sustainability concentration will prepare students to meet the challenges of the 21st-century electric grid and develop sustainable practices. Power engineers will lead the way in decarbonizing the electric grid, promoting sustainable energy generation, and electrifying transportation and the whole industry.

Choose six courses or more (18 graduate credits or more) from the list below:

- ETLS 744 Power Systems and Smart Grids
- ETLS 611 Introduction to Sustainability
- ETLS 739 EV Market and Technologies
- ETLS 754 Electrification
- ETLS 758 Grid Modernization
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines and Vehicles
- ETLS 748 Renewable Energy Generation

Technical Electives (up to 4 graduate courses or 12 credits):

Choose four technical electives from the course list below:

- ETLS 612 Sustainability Verification
- ETLS 745 Power Systems Operations and Controls
- ETLS 753 Power Systems Protection and Relay
- ETLS 756 Discrete Control of Power Electronics
- ETLS 757 Microgrids
- ETLS 810 Advanced Controls
- ETLS 620 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 Applications of AI in Engineering
- ETLS 679 Embedded & Cyber-Physical Systems
- ETLS 681 AI, Robotics & Autonomous Systems
- ETLS 683 Electronic Design of Implantable Medical Devices
- ETLS 684 PCB Engineering and Design
- ETLS 699 Selected Topics
- SEIS 663 Introduction to Cybersecurity
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLS 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

*Other electives approved by the Program Director.

The Embedded and Intelligent Systems concentration enables students to become proficient with microcomputers, sensors, interconnections, and their composite systems used to design and control devices. Embedded systems find their applications in automation, manufacturing, intelligent robotics, autonomous systems, medical devices, and more. When combined with artificial intelligence, it enables the embedded systems to be smart and make intelligent decisions targeted in Industry 5.0.

Choose six courses or more (18 graduate credits or more) from the list below:

- ETLS 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETLS 631 Wireless Sensor Networks
- ETLS 676 Real-Time DSP

- ETLS 678 Applications of AI in Engineering
- ETLS 679 Embedded & Cyber-Physical Systems
- ETLS 681 AI, Robotics & Autonomous Systems
- SEIS 663 Introduction to Cybersecurity
- SEIS 763 Machine Learning

Technical Electives (up to 4 graduate courses or 12 credits):

Choose four technical electives from the course list below:

- ETLS 620 Communication Systems
- ETLS 675 Digital Signal Processing
- ETLS 683 Electronic Design of Implantable Medical Devices
- ETLS 684 PCB Engineering and Design
- ETLS 810 Advanced Controls
- ETLS 611 Introduction to Sustainability
- ETLS 612 Sustainability Verification
- 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 and Vehicles
- ETLS 748 Renewable Energy Generation
- ETLS 753 Power Systems Protection and Relay
- ETLS 754 Electrification
- ETLS 758 Grid Modernization
- ETLS 756 Discrete Control of Power Electronics
- ETLS 757 Microgrids
- ETLS 699 Selected Topics
- SEIS 764 Artificial Intelligence
- ETLS 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

*Other electives approved by the Program Director.

The Circuits, Signals and Systems concentration focuses on the study of sensing, printed circuit board design, biomedical circuit design, communication, and processing of information. Applications can be found in all areas around us such as biomedical engineering, implantable medical devices, wearables, IoT, automation, robotics, mobile health care, and autonomous vehicles. Application of Artificial Intelligence to information processing, and communication of such information over a variety of communication networks such as Wi-Fi, Bluetooth, and 5G wireless networks are explored.

Choose six courses or more (18 credits) from the list below:

- ETLS 620 Communication Systems
- ETLS 630 Sensors for the Internet of Things (IoT) and Autonomy
- ETLS 631 Wireless Sensor Networks
- ETLS 675 Digital Signal Processing
- ETLS 678 Applications of AI in Engineering
- ETLS 683 Electronic Design of Implantable Medical Devices
- ETLS 684 PCB Engineering and Design
- ETLS 810 Advanced Controls

Technical Electives (up to 4 graduate courses or 12 credits):

Choose four technical electives from course list below:

- ETLS 676 Real-Time DSP
- ETLS 679 Embedded & Cyber-Physical Systems
- ETLS 681 AI, Robotics & Autonomous Systems
- ETLS 611 Introduction to Sustainability
- ETLS 612 Sustainability Verification
- 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 and Vehicles
- ETLS 748 Renewable Energy Generation
- ETLS 753 Power Systems Protection and Relay
- ETLS 754 Electrification
- ETLS 758 Grid Modernization
- ETLS 756 Discrete Control of Power Electronics
- ETLS 757 Microgrids
- ETLS 699 Selected Topics
- SEIS 663 Introduction to Cybersecurity
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- ETLS 881/882 Engineering Project Credits (2 consecutive semesters of 6 credits total)

*Other electives approved by the Program Director.

Master's in Engineering Management

The Master of Science degree in Engineering Management program empowers those seeking to successfully advance their professional development with leadership roles within technical-centric organizations. It accomplishes this via a combination of core and elective courses designed to be applied

directly in real-world business settings, delivered by a talented team of professors.

A central tenet of the program is to accomplish this in the context of today's unique challenges, which go well beyond the rate of technological change and includes efforts closely tied to sustainability and advancing the common good.

Upon completion, graduates will demonstrate competency in the core skills necessary to excel in diverse, collaborative cross-functional team environments working with all stakeholders to deliver innovative products and services to market. Ultimately, regardless of their current or future career aspirations, the M.S in Engineering Management will enable graduates to become role models and the strategic, visionary leaders needed in their organizations and society.

The program is designed to be flexible and provides two different degree plans, based on their educational backgrounds. For students who already have an Engineering (or similar field) bachelor's degree; or for students who have a bachelor's degree in other areas of study.

Students with a bachelor's degree in engineering (or similar field), complete eight foundational courses and two electives.

Students with a bachelor's degree in other areas of study will need to complete, in lieu of the electives, two additional graduate core courses (based on consultation with the program director and their area of interests).

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

Required Courses (8 graduate courses or 24 total credits):

- ETLS 525 Engineering Economics
- ETLS 551 Organizational Performance Excellence
  or ETLS 640 Lean Six Sigma
- ETLS 552 Supply Chain Synchronization & Forecasting
- ETLS 601 Program/Project/Team Management
- ETLS 660 Engineering Leadership
- ETLS 657 Product Lifecycle Management
- ETLS 755 Strategic Engineering Management
- ETLS 858 Engineering Capstone

Related Electives (2 graduate courses or 6 credits):

After consulting with the program director, choose two elective courses. The electives listed below are suggested to best fit to this master's degree program. Discuss with the program director if a different graduate engineering course(s) better align with your career goals.

Examples of elective courses recommended for M.S. in Engineering Management students include the following:

- ETLS 504 Excellence in Operations
- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 611 Foundations of Sustainability
- ETLS 671 Human Aspects of Technical Management
- ETLS 853 Managing Intellectual Property

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.

Requirements for students who have a B.S. in Manufacturing Engineering, Mechanical Engineering, or related field looking to obtain an M.S. in Manufacturing Engineering:

Complete a total of ten graduate courses (30 graduate credits) in the following Categories:

Leadership Category - Complete these three required courses:

- ETLS 703 Advanced Manufacturing Methods and Technologies
- ETLS 660 Leadership for Engineers
- ETLS 858 Engineering Capstone (Taken at end of program)

Manufacturing Engineering & Technical Skills Category

Select three graduate courses from the list below:

- ETLS 662 Computer-Aided Manufacturing and Machining Optimization
- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 520 Design and Manufacturing in the Medical Device Industry
- ETLS 555 Advanced Product Design
- ETLS 640 Lean Six Sigma
- ETLS 701 Design of Experiments
- ETLS 720 Anatomy and Physiology for Medical Devices
- ETLS 723 Biomaterials in the Design of Medical Devices
- ETLS 748 Renewable Energy Generation
- ETLS 770 Automated Control of Manufacturing Processes
- ETLS 771 Materials Engineering
- ETLS 774 Introduction to Mechatronics
- ETLS 777 Finite Element Analysis
- ETLS 779 FEA in Manufacturing
- ETLS 789 Simulation and Visualization
- ETLS 810 Advanced Controls

Manufacturing Operations & Management Category

Select 3 graduate courses from the list below:

- ETLS 501 Production and Operation Systems
- ETLS 504 Excellence in Operations
- ETLS 505 Managerial Accounting & Performance Management
- ETLS 551 Strategic Quality Management OR ETLS 722 Medical Device Quality Systems
- ETLS 552 Supply Chain Synchronization and Forecasting
- ETLS 601 Program/Product/Team Management OR ETLS 671 Human Aspects of Technology Management
- ETLS 739 EV Market Technologies
- ETLS 853 Managing Intellectual Property

Free Electives Category

Select one graduate course:

Choose any additional course from the Graduate Engineering (ETLS) course catalog. View the Graduate Engineering course catalog.

Requirements for students who have a B.S degree in a non-STEM field:

Complete a total of ten graduate courses (30 graduate credits) in the following Categories:

Foundational Category - Complete these 4 required courses:

- ETLS 502 Manufacturing Processes
- ETLS 503 Engineering Mechanics
- ETLS 513 Technical Communications
- ETLS 660 Leadership for Engineers

Manufacturing Engineering & Technical Skills Category

Select three graduate courses from the list below:

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 520 Design and Manufacturing in the Medical Device Industry
- ETLS 555 Advanced Product Design
- ETLS 640 Lean Six Sigma
- ETLS 701 Design of Experiments
- ETLS 720 Anatomy and Physiology for Medical Devices
- ETLS 723 Biomaterials in the Design of Medical Devices
- ETLS 770 Automated Control of Manufacturing

Processes
- ETLS 771 Materials Engineering
- ETLS 774 Introduction to Mechatronics

Manufacturing Operations & Management Category

Select 3 graduate courses from the list below:

- ETLS 501 Production and Operation Systems
- ETLS 505 Supply Chain Synchronization and Forecasting
- ETLS 551 Strategic Quality Management OR ETLS 722 Medical Device Quality Systems
- ETLS 552 Supply Chain Synchronization and Forecasting OR ETLS 570 Purchasing, Logistics and Distribution
- ETLS 601 Program/Product/Team Management OR ETLS 671 Human Aspects of Technology Management
- ETLS 739 EV Market Technologies
- ETLS 853 Managing Intellectual Property
- ETLS 858 Engineering Capstone (Taken at end of program)

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:

- Production operations systems, product development
- Manufacturing processes and statistical methods
- Advanced product design, thermal systems, polymer or experimental design
- 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 graduate courses or 30 credits)

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

Core Requirements: Design (4 graduate courses required or 12 credits)

Select four courses:

- ETLS 501 Production operations systems
- ETLS 502 Manufacturing Processes
- ETLS 520 Design and Manufacturing in the Medical Device Industry
- ETLS 555 Advanced Product Design
- ETLS 591 Advanced Product Design
- ETLS 672 Excellence in Product Design
- ETLS 701 Design of Experiments
- ETLS 723 Biomaterials in the Design of Medical Devices
- ETLS 773 Principles of MEMS Product Development
- ETLS 774 Introduction to Mechatronics
- ETLS 775 Polymers in Design
- ETLS 777 Finite Element Analysis
- 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 ETLS 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 Graduate Engineering Electives (2 courses required = 6 credits)

Choose any additional course from the Graduate Engineering (ETLS) course catalog OR the ETLS 881/882 Engineering Project course sequence. View the Graduate Engineering course catalog.

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

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

Core Requirements: Foundational (4 graduate courses required or 12 credits)

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

- ETLS 502 Manufacturing Processes
- ETLS 503 Engineering Mechanics
- ETLS 771 Materials Engineering
- ETLS 741 Heat Transfer and Fluid Mechanics

Core Requirements: Design (3 graduate courses required or 9 credits)

Select three courses:

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

Core Requirements: Analysis (3 graduate courses required or 9 credits)

Select three courses:

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 511 Circuit Analysis
- ETLS 591 Advanced Thermal Systems
- ETLS 701 Design of Experiments
- ETLS 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

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 graduate 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

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: Tier I Countries
- ETLS 880 Regulatory Science Project

Elective Courses:

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

Preferred Regulatory Science Electives:

- ETLS 601 Program/Project/Team Management
- ETLS 738 International Regulatory Affairs for Medical Devices: Tier II Countries
- ETLS 720 Anatomy and Physiology for Medical Devices
- ETLS 734 Clinical Evidence and Reimbursement
- Other Popular Regulatory Science electives include:
- ETLS 501 Production Operating Systems
- ETLS 502 Manufacturing Processes
- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 513 Technical Communications
- ETLS 671 Human Aspects of Technical Management
- ETLS 771 Materials Engineering

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 graduate courses (30 graduate semester credits) and maintain a GPA of at least 2.7.

M.S. in Systems Engineering – Systems Engineering concentration:

Required Courses (5 graduate courses or 15 total credits):

- ETLS 507 Systems Engineering I
- ETLS 508 Systems Design
- ETLS 509 Verification and Validation
- ETLS 601 Program/Project/Team Management
- ETLS 790 Modeling and Simulation

Electives (5 graduate courses or 15 credits required):

Note: No more than 3 graduate courses from each area can be selected unless otherwise approved by the Program Director.

Financial & Account Electives:

- ETLS 505 Managerial Accounting and Performance Management
- ETLS 661 Engineering Economic Analysis and Product Control

Human Aspects Electives:

- ELTS 671 Human Aspects of Technical Management

Modeling and Simulation Electives:

- ETLS 777 Finite Element Analysis
- ETLS 810 Advanced Controls

Software Electives:

- SEIS 601 Foundations of Java I
- SEIS 610 Software Engineering
- SEIS 739 Software Analysis, Design, and Implementation
- SEIS 640 Ethical Hacking and Operating Systems

Medical Device Electives:

- ETLS 520 Design and Manufacturing in Medical Device Industry
- ETLS 722 Medical Device Quality Systems
- ETLS 724 Medical Device Clinical Studies
- ETLS 731 Combination Products, Drugs, and Biologics
- ETLS 737 International Regulatory Affairs for Medical Devices: Tier I Countries

Technical Electives:

- ETLS 501 Production Operating Systems
- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 701 Design of Experiments
- ETLS 744 Power Systems
- ETLS 562 Specialty Engineering

Engineering Project (3 graduate credits)

Project proposal must be pre-approved by Program Director

- ETLS 881 Engineering Project I

M.S. in Systems Engineering – Industrial Engineering concentration:

Note: No more than 3 graduate courses from each area can be selected unless otherwise approved by the Program Director.

Required Courses (5 graduate courses or 15 total credits):

- ETLS 560 Industrial Engineering I
- ETLS 651 Operations Research and Analysis
- ETLS 563 Sustainment and Logistics
- ETLS 525 Engineering Economic Analysis
- ETLS 601 Program/Project/Team Management

Human Aspects Electives:

- ELTS 671 Human Aspects of Technical Management

Modeling and Simulation Electives:

- ETLS 777 Finite Element Analysis
- ETLS 810 Advanced Controls

Software Electives:

- SEIS 601 Foundations of Java I
- SEIS 610 Software Engineering
- SEIS 739 Software Analysis, Design, and Implementation
- SEIS 640 Ethical Hacking and Operating Systems

Medical Device Electives:

- ETLS 520 Design and Manufacturing in Medical Device Industry
- ETLS 722 Medical Device Quality Systems
- ETLS 724 Medical Device Clinical Studies
- ETLS 731 Combination Products, Drugs, and Biologics
- ETLS 737 International Regulatory Affairs for Medical Devices: Tier I Countries

Technical Electives:

- ETLS 501 Production Operating Systems
- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 701 Design of Experiments
- ETLS 744 Power Systems
- ETLS 562 Specialty Engineering

Engineering Project (3 graduate credits)

Project proposal must be pre-approved by Program Director

- ETLS 881 Engineering Project I

Graduate Programs in Engineering Certificates

The St. Thomas School of Engineering offers five graduate certificates that provide industry leaders and career changers an opportunity to specialize in the areas of Manufacturing, Medical Device, Power Electronics, and Sustainability 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 Advanced Manufacturing

The Graduate Certificate in Advanced Manufacturing trains you in using industry-standard software to simulate and solve common manufacturing problems in machining, materials, automated processes and statistical quality control.

You will gain practical hands-on experience with analytical tools that can help you improve process and yield, part quality and time-to-customer, and reduction of process costs. Learning these software tools and approaches will make you more effective at designing and improving manufacturing processes.

Students have the option to use coursework from their graduate certificate to continue in a M.S. in Manufacturing or M.S. in Mechanical Engineering degree offered through the School of Engineering at the University of St. Thomas.

Required Courses (6 graduate credits):

- ETLS 662 Computer Aided Manufacturing and Machining Optimization
- ETLS 779 Finite Element Analysis for Manufacturing

Elective Courses

Choose two electives from this list (6 graduate credits):

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 640 Lean Six Sigma
- ETLS 701 Design of Experiments
- ETLS 770 Automated Control of Manufacturing Processes
- ETLS 771 Materials Engineering

View the Graduate Programs in Engineering (ETLS) course catalog.

Graduate Certificate in Engineering Education: Engineering for Educators

The University of St. Thomas' School of Engineering and School of Education collaborate to provide the STEM Graduate Certificate in Engineering Education. This graduate certificate is designed for in-service PK-12 educators who want hands-on experience in STEM education with engineering. This program is a rigorous introduction to integrated STEM engineering content, with an emphasis placed on how to apply the material in PK-12 classrooms.

Courses in this program may be taken separately or as part of the STEM Graduate Certificate in Engineering Education and may be transferred into the University of St. Thomas Master of Arts in Educational Studies graduate program.

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

Required Courses (9 graduate credits):

- EGED 530 Fundamentals of Engineering
- EGED 531 Engineering Design
- TEGR 528 Engineering in the P-12 Classroom

Elective Courses

Choose an elective from this list (3 graduate credits):

- EGED 611 Fundamentals of Electricity and Electronics
- EGED 612 Digital and Computing Systems
- EGED 613 Materials Science and Engineering
- EGED 614 Manufacturing Engineering in the Classroom
- EGED 615 Statistics, Materials and Structures
- EGED 699 Independent Directed Study

Graduate Certificate in Engineering Leadership

The Engineering Leadership Certificate is designed to meet the needs of those wanting to improve their skills to effectively lead, mentor, and manage people in technologically oriented organizations. 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 (3 graduate courses or 9 total credits):

- ETLS 551 Organizational Performance Excellence or ETLS 640 Lean Six Sigma
- ETLS 601 Program/Project/Team Management
- ETLS 660 Engineering Leadership

Elective Courses:

Choose two graduate courses (6 graduate credits)

- ETLS 552 Supply Chain Synchronization
- ETLS 525 Engineering Economics
- ETLS 657 Product Lifecycle Management

To receive the Engineering Leadership certificate students must complete all three required courses, and two elective courses selected only from this list. No exceptions.

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 graduate courses = 9 credits):

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

Elective Courses:

Choose two courses (6 graduate credits)

- ETLS 505 Managerial Accounting and Performance Management
- ETLS 551 Strategic Quality Management
- ETLS 570 Purchasing, Logistics, and Distribution
- ETLS 601 Program/Project/Team Management
- ETLS 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 graduate courses or 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 elective course (3 graduate credits)

- ETLS 720 Anatomy & Physiology for Medical Devices
- ETLS 731 Combination Products, Drugs and Biologics
- ETLS 734 Clinical Evidence and Reimbursement
- ETLS 735 Preclinical Activities
- ETLS 737 International Regulatory Affairs for Medical Devices: Tier I Countries
- ETLS 738 International Regulatory Affairs for Medical Devices: Tier II Countries

Graduate Certificate in Power Electronics and Systems

Several prevailing factors combine to make the 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 Center for Microgrid Research, 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 graduate courses or 12 total credits):

- ETLS 744 Power Systems and Smart Grids
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines and Vehicles
- ETLS 748 Renewable Energy Generation

Elective Courses:

Students may also choose additional courses from Power Systems or Electrification or Sustainability concentrations in Master of Science in Electrical Engineering Program.

Graduate Certificate in Sustainability

The Graduate Certificate in Sustainability is designed to give students the knowledge and skills necessary to lead and manage sustainability initiatives and foster transformational change within organizations. Students of this certificate program will gain a deep understanding of sustainability principles and their practical applications, including the challenges and opportunities of transitioning to sustainable practices. Students will learn how to use sustainability assessment tools to measure, manage, verify, and report on their organization's sustainability efforts.

This interdisciplinary graduate certificate program is designed to be accessible to students from a variety of fields and backgrounds, including engineering, law, business, policy and more.

Students have the option to count coursework from their graduate certificate if they continue in a master's degree offered through the School of Engineering at the University of St. Thomas.

Required Courses

Complete these three courses (9 graduate credits):

- ETLS 611 Foundations of Sustainability
- ETLS 612 Sustainability Assessment, Verification, and Reporting
- MGMT 702 Leading Organizational Change

Elective Courses

Choose an elective from the list below, or discuss alternatives approved by the Program Director (3 graduate credits):

- ETLS 739 EV Market and Technologies
- ETLS 744 Power Systems and Smart Grids
- ETLS 747 Electrical Machines & Vehicle
- ETLS 748 Renewable Energy Generation
- ETLS 502 Manufacturing Processes
- ENTR 625 Entrepreneurial Thinking
- ENTR 708 Social Entrepreneurship
- SEIS 662 Enterprise Resource Planning (ERP)

and Analytics
- BETH 601 Business Ethics
- BCOM 637 Strategic Writing
- MGMT 623 Project Management
- MGMT 755 Strategic Sustainability

View the Graduate Programs in Engineering (ETLS) course catalog.

Graduate Programs in Engineering Micro-Credentials

Graduate Micro-Credential in Statistical Quality Control & Design of Experiments

The Graduate Micro-Credential in Statistical Quality Control and Design of Experiments (DOE)program is designed for professionals who are responsible for product development and/or manufacturing process improvement who would like to increase their skills in applied statistical software (such as Minitab). Students participating in this program will gain skills in applying statistics to a wide variety of manufacturing and design engineering situations.

Program benefits include: reducing part-to-part variation, lowering cost, improving reliability, and factoring out the "noise" in a manufacturing process to determine the most significant control factors.

Taught by Tom Keenan, a leading industry expert in applied statistical software, this graduate-level micro-credential is a practical and industry-relevant way to gain expertise quickly in an ever-changing landscape and realize a competitive edge.

In just two classes, you will earn a micro-credential and digital badge to bolster your resume and online profile. Badges are a convenient way to digitally showcase and share expertise and help differentiate yourself in the market.

Students have the option to use coursework from this graduate micro-credential to continue in a graduate certificate or master's degree program in manufacturing engineering or mechanical engineering offered by the School of Engineering.

To complete the Graduate Micro-Credential in Statistical Quality Control and Design of Experiments (DOE), you must complete the following two required graduate engineering courses (6 graduate semester credits) with a GPA of 2.7 or higher:

Two Required Courses (6 graduate credits):

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 701 Design of Experiments

View the Graduate Programs in Engineering (ETLS) course catalog.

Graduate Programs in Engineering Course Catalog

ETLS 501 PRODUCTION AND OPERATIONS SYSTEMS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

An overview of manufacturing processes with the objective of establishing the processes most appropriate to the characteristics and production requirements of the product. Metallurgy is briefly reviewed as a basis for material processing. Many conventional methods of fabrication are covered. Design for manufacturing and assembly techniques will be studied along with assembly methods and flow. Clean rooms and electronic assembly are also covered. Students unfamiliar with manufacturing processes will need to do independent study to determine all of the processes available.

ETLS 503 ENGINEERING MECHANICS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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 MANUFACUTING QUALITY

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: ETLS 507 Introduction to 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.

ETLS 509 VERIFICATION & VALIDATION

[3 Credits]

Prerequisite: ETLS 508 - Systems Design

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.

ETLS 511 CIRCUIT ANALYSIS

[3 Credits]

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.

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.

ETLS 512 CONTROL SYSTEMS AND AUTOMATION

[3 Credits]

Prerequisite: ETLS 511

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

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.

ETLS 513 TECHNICAL COMMUNICATIONS

[3 Credits]

Prerequisite: None

Technical communication is an essential skill for a successful engineering career. Well start with the ethical basis for technical communication and what distinguishes it from other kinds of writing and speaking. Topics include the mechanics of writing and editing; the parts of a technical report; ways to organize the material; graphs, images, and tables; and maintaining objectivity. Students will gain practice in writing short forms such as executive summaries, instructions, and emails as well as longer reports. They will also learn to use Excel to make effective tables and graphics. They will practice effective oral communication using PowerPoint and other visual aids. We will also cover tips for projecting one's voice, connecting with the audience, and giving testimony. This course is intended for graduate students in the M.S. Manufacturing Engineering or M.S. in Mechanical Engineering degree program. It will be required by students who do not have an undergraduate degree in Engineering or related STEM field of study.

ETLS 520 MANUFACTURING IN MEDICAL DEVICE INDUSTRY

[3 Credits]

Prerequisite: None

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.

ETLS 520 DESIGN AND MANUFACTURING IN THE MEDICAL DEVICE INDUSTRY

[3 Credits]

Prerequisite: None

This course is designed to provide an introductory overview of the medical device industry, and it's 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 are 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.

ETLS 525 ENGINEERING ECONOMICS

[3 Credits]

Prerequisite: None

The purpose of this course is to introduce engineers to some of the financial and economic principles and concepts they will face in the workplace. A successful engineer not only has full mastery of engineering subject matter but also mastery of fundamental business practices and principles around cost management in the New Product Introduction process, product revisions and addressable market expansion. Topics will include cashflow analysis, simple and compound interest, minimum attractive rate of return, present and future value of cashflows, internal and external rate of return, Cost/Benefit analysis, Cost of Capital, repair/replace decisions, breakeven and payback analysis and other topics.

ETLS 551 ORGANIZATIONAL PERFORMANCE EXCELLENCE

[3 Credits]

Prerequisite: None

The DSR model provides a framework for better understanding your business and when and where to take action to improve results. The DSR model is a tool that links company mission, vision, strategic plans, competitive positioning, and customer focus as the Driver. The System consists of the workforce and operational processes that design, produces, and delivers products and services. Results measure the performance of an organization in leadership, financial, customer, employee, and process areas. The DSR model is underpinned with the information and knowledge necessary to make fact-based decisions. The course connects the DSR model to the Baldrige Excellence Framework and continuous improvement tools such as Plan-Do-Check-Act and A3 problem solving methodologies.

ETLS 552 SUPPLY CHAIN SYNCHRONIZATION

[3 Credits]

Prerequisite: None

This application-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

[3 Credits]

Prerequisite: None

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 560 INDUSTRIAL ENGINEERING I

[3 Credits]

Prerequisite: None

This course outlines concepts and Industrial Engineering procedures that are utilized to enhance and optimize production systems and manufacturability of new product development. These areas of familiarity include Manufacturing Processing Systems, Operations Systems Design, Production Planning Systems, Six Sigma, and Lean Manufacturing. This course is designed to enable the students to identify areas of interest within the Industrial Engineering domain area for further study.

ETLS 561 OPERATIONS RESEARCH

[3 Credits]

Prerequisite: None

This course outlines concepts and Operations Research procedures that are employed with decision making in engineering production. Course content will focus on areas of manufacturing optimization using numerical techniques. Topic areas will include Mathematical and Engineering methods for Optimization Problems, Linear programming, Non-linear programming, Queuing Theory, Systems Modeling of manufacturing processes, and Personnel Scheduling.

ETLS 562 SPECIALTY ENGINEERING

[3 Credits]

Prerequisite: None

This course outlines concepts related to Specialty Engineering domain areas in the Systems Engineering discipline. These areas are associated with specific skills requiring a high degree of specialization on the part of the practitioner. These areas include Human factors, usability, electromagnetic interference, electrical grounding, safety, security, cybersecurity, electrical power filtering/supply, manufacturability, and environmental engineering may be included in systems engineering efforts where they have been identified to address special system implementations. This course will cover each of the domain areas to ensure the student becomes familiar with the concepts but will not necessarily become professionally proficient in them.

ETLS 563 SUSTAINMENT AND LOGISTICS

[3 Credits]

Prerequisite: None

This course outlines concepts and Sustainment and Logistics procedures that are utilized to ensure the successful production of a given product or system as well as the ability to sustain that product over the expected life cycle of the system. These concepts include Sustainment in Operations and Product Design, including Anticipation, Continuity, Responsiveness, Integration, Improvisation, and Economy

Also discussed is the area of Logistics and Supply Chain including Supply, Maintenance, Deployment,

Distribution, Logistic Services, Contract Support, and Sustainment levels.

ETLS 570 PURCHASING, LOGISTICS AND DISTRIBUTION

[3 Credits]

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

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.

ETLS 571 AUTOMATION SYSTEMS IN THE US AND OVERSEAS

[3 Credits]

Prerequisite: None

This course provides an examination of automation and the processes and systems in which is 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

[3 Credits]

Prerequisite: None

This course provides 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

[3 Credits]

Prerequisite: None

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 611 FOUNDATIONS OF SUSTAINABILITY

[3 Credits]

Prerequisite: None

This course provides an overview of the key natural, social, economic and governance systems, principles and perspectives impacting a sustainable future. Using Electric Vehicles as a springboard, we will address the complex natural systems (water, land, climate) and social systems (economics, government, business) involved in improving human and environmental health and successfully transitioning to sustainable technology. Through case studies and practical exercises, students will develop a deep understanding of the interdependent systems impacted when developing and implementing sustainable and regenerative practices in a range of industries and sectors.

ETLS 612 SUSTAINABILITY ASSESSMENT VERIFICATION

[3 Credits]

Prerequisite: None

This course introduces the key principles, tools, and frameworks used to assess, verify, and report on sustainability in a variety of settings, including product development, manufacturing, construction, and business operations. Students will learn how to use tools such as life cycle assessment (LCA), environmental product declarations (EPDs), and the Cradle to Cradle (C2C) framework to evaluate the environmental, social, and economic impacts of products and services. They will also explore reporting frameworks such as the

Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC) framework, and the Sustainability Accounting Standards Board (SASB) and verification protocols such as ISAE 3000 and the AA1000 Assurance Standard. Through case studies and practical exercises, students will develop skills in analyzing, interpreting, and communicating sustainability information, and gain a deeper understanding of the role of sustainability in achieving sustainable development. By the end of the course, students will be prepared to use a variety of sustainability assessment, verification, and reporting tools to develop and implement sustainable practices in a range of industries and sectors.

ETLS 620 COMMUNICATION SYSTEMS

[3 Credits]

Prerequisite: ENGR 340 or approval from instructor.

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.

ETLS 630 SENSORS FOR IOT AND AUTONOMY

[3 Credits]

Prerequisite: None

The “Things” that comprise the Internet of Things (IoT) include integrated sensors that measure their environment. This course will study the electronics, physics, and performance characteristics of these sensors. We will study sensors that measure acceleration, relative humidity, temperature, magnetic fields, ambient light, pressure, and gas composition. Autonomous machines, including driverless cars and factory robots, also rely upon sensing. In the second half of this course, we will investigate the characteristics, design, and operation of the critical sensing systems of these devices, including 2D cameras, cameras for depth sensing, LIDAR, and radar. We will apply our understanding of the sensors studied, to applications that include smart homes, autonomous vehicles, and wearables for health monitoring.

ETLS 631 WIRELESS SENSOR NETWORKS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

Lean Six Sigma is a course designed to equip students with practical problem-solving skills and hands-on experience in Lean Six Sigma methodology, to better prepare and be more competitive for jobs. Instead of focusing on theoretical knowledge, the course is structured in a workshop style setting that the class will break into multiple teams, each working on a capstone style project from real-life (from class) throughout the course. This setting will allow students to systematically apply the newly learned Lean Six Sigma methodology and tools in a just-in-time fashion that leads to the final project report, to effectively tell the story and journey of what have been done and achieved - a much-needed capability at work. This course, while devoting 1 session to review relevant statistical analytics, will focus on non-statistical tools and can be used to prepare for Lean or Six Sigma certification.

ETLS 652 TECHNOLOGY FORECASTING AND RISK MANAGEMENT

[3 Credits]

Prerequisite: None

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.

ETLS 657 PRODUCT LIFECYCLE MANAGEMENT

[3 Credits]

Prerequisite: None

The course will provide students with real-world strategies and techniques to effectively navigate each stage of the product lifecycle process, from ideation to market delivery and sunset. Each phase will be examined to identify best practices and measurement criteria for successful completion. Since exit criteria and process flow will be examined, the student will learn methods used to bring an enhanced or new product or service to successful realization along with mindset to react as required to changing market conditions that may impact their product introduction plans. This will be accomplished by utilizing a combination of lecture, discussion, group assignments, readings, books, and an individual project to reinforce key course concepts.

ETLS 660: ENGINEERING LEADERSHIP

[3 Credits]

Prerequisite: None

The course addresses three basic questions: 1. What makes for a highly effective leader? 2. Who am I as a leader and how do I exhibit my leadership? 3. How do I develop my leadership? It is designed to develop engineering students' leadership capabilities by building their own 'roadmap' for their leadership; increasing clarity about oneself 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. Designed in seminar format, the course provides students with multiple readings, personal assessments, exercises and case studies, guest speakers, and large and small group dialogue. Students are encouraged to consider a vision of their career within a global mindset and grounded in the Engineering Code of Ethics. Assignments are intended to facilitate career management and presenting oneself as a professional and as a leader.

ETLS 662 COMPUTER AIDED MANUFACTURING & MACHINING OPTIMIZATION

[3 Credits]

Prerequisite: None

This course will cover computer-aided manufacturing (CAM) programming for CNC mills, machining theory, and machining optimization software. In this project-based course students will create their own G-code using CAM software to be run on CNC machines. The theoretical calculation of machining forces and power requirements as well as tool wear modeling is covered. State-of-the-art machining optimization software will be used to identify machining process improvements for balancing of tool loads, reducing cycle times, reducing tool costs and improving part quality.

ETLS 671 HUMAN ASPECTS OF TECHNICAL MANAGEMENT

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

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

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.

ETLS 678 APPLICATIONS OF AI IN ENGINEERING

[3 Credits]

Prerequisite: None

Introduction to wearable sensor systems, applications, data analysis and IoT. Through this course, you will learn how to develop wearable platforms for various different applications. Applications include, but are 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

[3 Credits]

Prerequisite: None

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 681 AI, ROBOTICS & AUTONOMOUS SYSTEMS

[3 Credits]

Prerequisite: None

This course discusses the application of intelligent robots, such as navigation and control, using machine vision-based artificial intelligence, which is essential for the decision-making of intelligent autonomous robots required in Industry 5.0 and various next-generation industries. Learn the functions of vision and lidar sensors for robots to obtain information from the environment, navigation, control, and convergence technology of computer vision. In detail, ROS (Robotics

Operating System), image analysis in which the characteristics of a single image, a moving sequence of images, and a moving camera, including the use of traditional computer vision algorithms, are discussed. Acquisition of image information from vision sensors, theories and programming practice of object recognition technology, and application skills through robot control are acquired. The course also discusses the diverse robot applications expected to be seen in Industry 5.0 coupled with artificial intelligence/deep learning.

ETLS 683 ELECTRONIC DESIGN FOR IMPLANTABLE MEDICAL DEVICES

[3 Credits]

Prerequisite: None

This master's level course walks students through the design of an active implantable medical device (AIMD) with discussion of the components common to all AIMDs including power management, communication, data management, and sensing with the addition of stimulation circuitry for a pacemaker. Emphasis for the class is placed on evaluating electronics under the conditions they are exposed to during the lifetime of the device. Upon completion of the course students will have an understanding of design considerations and common techniques used to support operation and functionality in implantable medical devices.

ETLS 684 PRINTED CIRCUIT BOARD (PCB) ENGINEERING AND DESIGN

[3 Credits]

Prerequisite: None

This master's level course provides an in-depth exploration of Printed Circuit Board (PCB) design, that targets board designers, PCB project leaders, and layout engineers. The course will cover stack-up design, details of board materials, and methods for impedance control. Emphasis is placed on power distribution strategies and design considerations for electromagnetic compatibility. Surface mount technology (SMT) is extensively studied, encompassing standard passive and active component packages and the assembly process. The course addresses testing, including the development of test plans and functional and in-circuit tests. Design for manufacturability principles are integrated throughout the course with a focus on understanding the rationale behind design rules. Thermal analysis and management techniques are explored to ensure the reliability and efficiency of PCB designs in various operating conditions. Through theoretical instruction, practical applications, board design reviews, and board testing participants will develop advanced skills essential for proficient modern PCB design.

ETLS 699 SELECTED TOPICS

[3 Credits]

Prerequisite: None

Various engineering topics will be presented. (This course may be repeated for credit.)

ETLS 701 DESIGN OF EXPERIMENTS

[3 Credits]

Prerequisite: None

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 statistical 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 application - oriented course that includes case studies, team projects, student presentations and reports, guest lecturers and the 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 for 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 703 ADVANCED MANUFACTURING METHODS AND TECHNOLOGY

[3 Credits]

Prerequisite: None

This seminar-styled course is a series of topics related to advanced manufacturing methods and technologies that are current best practices, leading edge, and emerging on the horizon. Topics included will inherently be an ever-changing list, gathered from manufacturing publications, trade expositions, professional groups, and other sources. Students will be surveyed for suggested topics of common interest and will be encouraged to share real examples from their workplace (without disclosing proprietary information).

ETLS 720 ANATOMY & PYSIOLOGY FOR MEDICAL DEVICES

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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 COMBINATION PRODUCTS, DRUGS & BIOLOGICS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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 to choose real or hypothetical medical device.

ETLS 737 INTERNATIONAL REGULATOR AFFAIRS FOR MEDICAL DEVICES: TEIR I COUNTRIES

[3 Credits]

Prerequisite: None

This class will provide a comprehensive understanding of regulations for medical devices in major Tier 1 Countries including Japan, Canada, and the EU/EEA/EFTA countries and the relationship between regulatory strategy and product development. It will include discussion and case studies of the current regulatory climate to help students develop practical applications/interpretation and enforcement of these regulations.

ETLS 738 INTERNATIONAL REGULATOR AFFAIRS FOR MEDICAL DEVICES: TEIR II COUNTRIES

[3 Credits]

Prerequisite: None

This class will provide a comprehensive understanding of regulations for medical devices in Australia, New Zealand, South Africa, Israel and key Tier II countries (defined by FDA as those not in Tier I) including China, South Korea, Brazil, Mexico, as well as major Asia/Pacific, Middle East and Latin American countries, and the relationship between regulatory strategy and product development. The course includes discussion of medical device regulation and case studies of the current respective regulatory climate to help students develop practical application, interpretation, and enforcement of these regulations.

ETLS 739 EV MARKET & TECHNOLOGIES

[3 Credits]

Prerequisite: None

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 the 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 741 HEAT TRANSFER AND FLUID FLOW

[3 Credits]

Prerequisite: None

Modes of heat transfer: convection, conduction and radiation. Coupling for convective heat transfer with fluid flow. Fundamentals of fluid flow: statics, boundary layers pipe flows, pressure drop and friction factor. Convective heat transfer at external surfaces and internal surfaces. C Conduction in solids of various shapes; use of heat- conducting fins to improve performance of heat exchangers. Radiation heat transfer between surfaces.

ETLS 744 POWER SYSTEMS & SMART GRIDS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisites: ETLS 744

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 graduate students in Electrical Engineering and upper level undergraduates.

ETLS 746 POWER ELECTRONICS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: ETLS 511 or enrolled in the MSEE program or permission of the instructor.

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

[3 Credits]

Prerequisite: None

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 753 POWER SYSTEM PROTECTION & RELAYS

[3 Credits]

Prerequisite: ETLS 744

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.

ETLS 754 ELECTRIFICATION

[3 Credits]

Prerequisite: None

This course will introduce and discuss the current trends in the industry, provide perspectives and in-depth technical knowledge to drive and prepare current power engineers for the upcoming migration to clean energy. The course is centered around the electrification of current industries, such as electric vehicles in mobility, mass transportation, construction and their impact on the grid. Lastly, modeling and developing electrification technologies to solve future challenges are treated in depth.

ETLS 755 STRATEGIC ENGINEERING MANAGEMENT

[3 Credits]

Prerequisite: None

This course is designed to instill a strategic mindset that will enable students to successfully exploit external opportunities while addressing challenges and threats from a manager or executive perspective. Questions include: What are the strategies of the organization? Competitive advantages? Core competencies? How do we pursue these? Does the engineering organization have a technology roadmap to success? Do the current investments align?

Closely related topics include risk management, the impact of global megatrends, M & A, due diligence, joint ventures, and intellectual property protection.

In short how to think like a successful executive. You are now in charge of your company's engineering organization. They are going to invest 3% in anything you decide. Output would include a "mini-business case" for engineering organization. Networking is key, they need to be working cross-organizationally (Personal Branding—how do I shape this), Make vs buy.

ETLS 756 DISCRETE CONTROL OF POWER ELECTRONICS

[3 Credits]

Prerequisite: None

Power Electronics (PE) systems (PES) efficiently transform input electrical power in one form to an electrical output in another form, e.g. DC in, AC out. A complete PES is comprised of several subsystems. For example, a PES typically includes the PE conversion electronics, the controls subsystem, the PCB which effectively integrates all PES subsystems, and finally, the thermal management and safety/fault protection subsystem. The common PE topologies associated with the input-output transformation of electrical power are covered in ETLS-746 Power Electronics.

This course is a follow-on to ETLS-746 Power Electronics as an exciting transformation is currently underway with regard to how PES are controlled. Traditionally, PES were controlled using classical analog methods. Over the past decade, state-of-art DSPs, FPGAs, and microcontrollers have become sufficiently capable to enable the discrete control of modern PES. In this PE controls class the foundations of state-space methods of discrete control of PES will be introduced and covered along with particular attention given to model predictive control (MPC) methods as applicable to PES.

ETLS 757 MICROGRIDS

This graduate course introduces the student to the principles and operation of microgrid systems, exploring their design, operation, and integration with the main power grid. Students will gain a comprehensive understanding of fundamental principles and real-world insights using case studies from the St Thomas Center for Microgrid Research. The course covers diverse topics, including microgrid design, control systems, operations, and protection.

ETLS 758 GRID MODERNIZATION

[3 Credits]

Prerequisite: None

This course focuses on grid modernization concepts and emerging technologies that are transforming the ways in which electric energy is generated “made”, delivered “moved”, and utilized “used”. The power industry has been rapidly modernizing over the past few decades, and it is now at a critical juncture as it enters a new era of innovation, demanding many decisions to be made that will impact generations to come. One significant aspect of this change is the emergence of Distributed Energy Resources (DER), including Microgrids, which offer fundamentally different characteristics and capabilities from our past generation mix. At the same time, new enabling technologies such as Information and Communication Technology (ICT) and advanced operational software provide grid operators with significantly improved situational awareness and control over the grid conditions. Additionally, Artificial Intelligence (AI) is expected to play a significant role in utility planning and operational tools, optimizing and creating new ways of allocating resources and improving efficiency. The key to “all this” is “architecting a grid” that can seamlessly integrate diverse electricity supply-side and demand-side resources, while energy policy and industry standardization guide the path towards a safe, reliable, resilient, environmentally responsible, and cost-effective grid of the future.

This course explores the multifaceted components of grid modernization, which are integral to the evolution of power system planning, operations, and electricity markets in the coming years. We begin by examining policy, customer, and business objectives, which serve as the primary driver for modernizing the grid. We then proceed to understand and classify the necessary functions and capabilities that support these objectives. These functions and capabilities are implemented through emerging technologies, which require an evaluation of their maturity levels. We will discuss how to evaluate the maturity levels of these technologies. Subsequently, we explore the Department of Energy (DOE) guidelines for formulating grid modernization strategies and implementing new smart grid technology. We also introduce a cost-effectiveness framework that discerns valuation approaches depending on the type of investment being considered. These guidelines are the product of consensus-building efforts spearheaded by the DOE, in collaboration with key stakeholders such as state public commissions, industry representatives, and technology providers.

ETLS 770 AUTOMATED CONTROL MANUFACTURING PROCESS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

This course introduces the student to theory and the 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 773 PRINCIPLES OF MEMS PRODUCT DEVELOPMENT

[3 Credits]

Prerequisite: None

The field of Micro-Electro-Mechanical Systems (MEMS) refers to the design and manufacture of micron-scale devices which can ultimately be used to create both sensors and actuators that promise to be very small, very lightweight, very inexpensive and very precise. By leveraging the mature state of semiconductor fabrication techniques within the integrated circuit industry, MEMS devices are beginning to emerge in the automotive, medical, aerospace, telecommunication, and biotechnology industries. This course will investigate the entire process of developing a micro-sensor idea into a product. Along with way, topics of discussion will include picking an appropriate application of the MEMS technology; designing a MEMS device; MEMS fabrication and packaging techniques, the challenging aspects of characterizing MEMS devices, and the unique physical environment that exists at the micron scale. Other discussions will address the existing MEMS market, the future of MEMS and the difficulties associated with establishing a successful MEMS business. The course will be taught through real world examples of existing MEMS implementations, drawing on both the successes and failures of past efforts to paint a realistic view of this exciting yet challenging new technology.

ETLS 774 INTRODUCTION TO MECHATRONICS

[3 Credits]

Prerequisite: None

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 775 POLYMERS IN DESIGN

[3 Credits]

Prerequisite: ETLS 771

This course focuses on describing: what polymers are; how they are manufactured; why they behave the way they do; and how they are fabricated into structural

objects-parts, fibers, films; how they can be compounded into alloys, reinforced composite structures, flexibilized toughened structures; how they are increasingly being used in functionally active roles, photopolymers as imaging elements in the printing and electronics industries, polymer membrane in separation processes, polymer fiber optics, photonic elements and optical discs. The presentation method is highly descriptive with frequent reference to commercial examples and attempts to avoid, to the degree compatible with qualitative understanding, detailed excursions into underlying chemistry and rigorous mathematical physics.

ETLS 776 MATERIALS DESIGN & DEVELOPMENT

[3 Credits]

Prerequisite: None

This course will cover the materials design cycle from a product development viewpoint, utilizing a variety of materials characterization techniques driven by the desired performance of the final product. This course will explore materials design and development from an applied/industrial research & development (R&D) perspective. Applied characterization of material properties and structures will be investigated. The student will be exposed to a variety of materials product designs and learn how to analyze and interpret data from a variety of characterization tests in order to make informed choices for future materials development/use. Note that prior study of materials through an introductory materials science and engineering course is strongly recommended.

ETLS 777 FINITE ELEMENT ANAYLSIS

[3 Credits]

Prerequisite: None

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. Solutions 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

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

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 790 MODELING AND SIMULATION FOR SYSTEMS ENGINEERING

[3 Credits]

Prerequisite: None

This is an introductory course on modeling and simulation. Its purpose is to give engineering students of different engineering disciplines experience using the basic principles involved in creating models and simulations to address complex problems. The emphasis will be on the basic principles involved in modeling and simulation and the limitations of modeling and simulation. The specific principals are: (1) Problem formulation, (2) Setting model objectives, (3) Model conceptualization, (4) Data collection, (5) Model translation (translation to a simulation language- this class will use Microsoft Excel as a simulation language), (6) model verification and validation, (7) Simulation, and (8) documentation and reporting. Since the focus is on principles and not on tools, the need to learn new tools has been minimized using Microsoft Office tools (Word, Power Point and Excel) and an intuitive modeling language IDEF0 (Integrated Definition Modeling. The course will require students to demonstrate basic modeling and simulation skills by means of creating models and simulations that address a variety of complex problems. Discrete and continuous models will be covered as will deterministic and stochastic models.

The course will have a semester long Request for Information (RFI) project that will capture what the students understand about modeling and simulation. The students will be organized into competing teams that will be required to respond to a Request for Information (RFI) that will ask them to compete for the role as a modeling and simulation contractor to a large systems integration company. The RFI will be presented to the students during the first week of class. The RFI will ask the teams to demonstrate that they understand how to model and simulate several different domains. During the class the students will learn how to model and simulate in those domains.

The modeling and simulation principles and the experience they get using those principles during the course will provide the student with modeling and simulation skills that they will be able to apply in their careers.

ETLS 795 INDEPENDENT STUDY

[3 Credits]

Prerequisite: Department Approval

One semester Engineering Independent Study.

ETLS 784 INTERNSHIP

[0 Credits]

This zero-credit course is intended for students needing to register for an internship.

ETLS 810 ADVANCED CONTROLS

[3 Credits]

Prerequisite: None

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

[3 Credits]

Prerequisite: None

This course is considered a seminar series meaning that the majority of
sessions will be conducted by industry experts in a variety of pertinent and relevant information systems/technology topics. The reason for this type of class format is to better provide an enriching student experience as no one instructor can be an expert in all of the changing world of information technology. Topics covered will include, but is not limited to the following: Role of IT/IS in an organization and typical structures, IT strategic planning, requirements definition and vendor negotiations for new systems, project management, security, data analytics, the role
of social media, e-commerce, various development and emerging design tools/techniques, and
future of IT. Students, in small groups, will also present a selected topic on other emerging trends such as RFID, Internet of Things, 3D printing, IBM Watson, etc.

ETLS 853 MANAGING INTELLECTUAL PROPERTY

[3 Credits]

Prerequisite: None

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

ETLS 858 ENGINEERING CAPSTONE

[3 Credits]

Prerequisite: To register, students must be within six credits of completing their degree (excepting the Capstone) and have no grades of Incomplete.

The Engineering Capstone course provides graduating master's 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 personal 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.

ETLS 880 REGULATORY SCIENCE PROJECT

[3 Credits]

Prerequisite: Advisors consent

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.

ETLS 881/882 ENGINEERING PROJECT CREDITS

[3 Credits]

Prerequisite: Department Approval

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.

Department of Software Engineering and Data Science Course Catalog

SEIS 601 FOUNDATIONS OF JAVA I

[3 Credits]

Prerequisite: None

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

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: None

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

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 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: None

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.

SEIS 625 SOFTWARE PROJECT MANAGEMENT

[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 622 WEB APP DEVELOPMENT

[3 Credits]

Prerequisite: SEIS 602 or 604

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 transactions 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 627 SOFTWARE AGILE PROCESSES

[3 Credits]

Prerequisite: None

This course will provide students with a comprehensive overview of the principles, processes, and practices of many available agile software product development techniques. Students will learn agile planning, development, and delivery techniques with Scrum, Kanban, Lean, Extreme, Crystal, Dynamic, and Feature Driven Development. Scaled agile framework (SAFe) for large enterprises in scaling lean and agile practices beyond a single team along with Large-scale Scrum (LeSS) and disciplined agile delivery (DAD) will also be explored. Students will be provided with the opportunity to apply skills in creating and delivering new products in a team environment. Drivers behind agility in software development along with methods for project tracking, project communication, team collaboration, client relationship management, stakeholder management and quality of deliverables will be discussed at length.

SEIS 628 DIGITAL PROJECT MANAGEMENT

[3 Credits]

Prerequisite: None

The class will Introduce students to digital product management for technology-driven enterprises. Topics include detail exploration of Discovery, Design, Define, and Deliver phases including opportunity discovery, product-technology road mapping, product development processes, go-to-market strategies, product launch, lifecycle management, along with an emphasis of product managers role in each phase of the Product Management. Many common digital tools like storyboarding, wireframe mock-ups, and A/B testing will be discussed at great lengths. This class Includes a project in which teams will exercise idea conception, design, and prototyping, covering key areas such as design thinking, product planning, product management, and agile development.

SEIS 630 DATABASE MANAGEMENT SYSTEMS AND DESIGN

[3 Credits]

Prerequisite: None

This course focuses on database management system concepts, database design, and implementation. Conceptual data modeling using Entity Relationships (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 aid system performance.

Structured Query Language (SQL) is used to work with a database using the Oracle platform. The course also covers query optimization and execution strategies, concurrency control, locking, deadlocks, security, and backup/recovery concepts. Non-relational databases are also briefly introduced. Students will use Oracle and/or SQL Server to design and create a database using SQL as their project.

SEIS 631 FOUNDATIONS OF DATA ANALYSIS

[3 Credits]

Prerequisite: SEIS 603

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.

SEIS 632 DATA ANALYTICS AND VISUALIZATION

[3 Credits]

Prerequisite: None

Even the most insightful data analysis has limited value if analysts cannot convey clear, actionable insights to non-technical audiences. This course develops the critical skills necessary to transform complex quantitative findings into compelling data stories and visualizations. Students will learn how to leverage visual design principles that speak directly to human cognitive abilities, guiding business stakeholders toward data-driven decisions. The curriculum covers creating meaningful graphs, reports, and dashboards that improve comprehension, catalyze communication, and enable fact-based choices. By mastering techniques for visualizing and explaining data, students will become adept at distilling analytical conclusions into incisive narratives readily grasped by diverse audiences. Upon completion, they will have obtained hands-on experience with state-of-the-art data visualization tools to generate impactful data-driven visual insights.

SEIS 639 AI FOR HEALTHCARE

[3 Credits]

Prerequisite: SEIS 631 and SEIS 632. SEIS 632 can be taken concurrently.

New Artificial Intelligence approaches provide powerful capability in analyzing complex and heterogeneous data that were 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 640 ETHICAL HACKING & OPERATING SYSTEMS

[3 Credits]

Prerequisite: None

This course introduces the basic concepts involved in ethical hacking. An ethical hacker assesses software security by looking for weaknesses and vulnerabilities in target systems. An effective ethical hacker must understand network communications, software development, and operating systems internals. The course begins with a review of the fundamental topics of operating systems design. Topics such as process scheduling, input/output, memory management, file system design, security, and protection mechanisms are covered. The course continues with activities performed by ethical hackers, such as testing via injection attacks, searching for broken authentication, identifying security misconfigurations, and pinpointing data exposure.

SEIS 651 AI ETHICS

[3 Credits]

Prerequisite: None

The purpose of this course is to guide students through the knowledge, skills, and opportunities needed to develop an ethical foundation on which they can build their careers as AI practitioners or as professionals in other fields that have been or will be impacted by AI. We will explore a variety of ethical issues related to the development and use of AI across multiple fields of study, with an emphasis on the human impact of AI. Course topics will cover a range of foundational AI concepts including data preparation, bias, neural networks, natural language processing, large language models, generative AI, model validation, and more, in the context of issues like discrimination, misinformation, intellectual property, regulation, jobs, and humanity at large. Class sessions are comprised of a weekly "hot topic" where we will explore the ethical implications of current events in AI, a lecture period, and lab where students have the opportunity to discuss and apply the course material to practical and theoretical exercises. This course is intended for both technical and non-technical audiences.

SEIS 663 INTRODUCTION TO CYBERSECURITY

[3 Credits]

Prerequisite: None

This overview 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), digital privacy, technology risk management, regulatory compliance, and security operations (e.g., incident response, monitoring, continuity). We will explore social engineering and other human factors and the impact on security.

SEIS 666 DIGITAL TRANSFORMATION

[3 Credits]

Prerequisite: None

Digital transformation promises a bridge to a digital future, where organizations can thrive on more fluid business models and processes. Less than 20% of organizations are getting digital transformations right, but these digitally transformed organizations can deliver twice as fast as other organizations. Large language models (LLMs) and ChatGPT, automation and AI will supercharge further change into a second chapter of radical change. Digital Transformation 2.0 is an innovative course that delves into the world of digital transformation, focusing on the new change, the Future of Work and the impact of ChatGPT and Generative AI technologies on modern businesses and industries. This course provides students with hands-on experience using ChatGPT and other AI tools while exploring digital maturity models and the establishment of a Generative AI Center of Excellence (GAICoE). Students will learn how to integrate AI-driven solutions into business processes and strategies, transforming the way organizations operate in the digital age.

SEIS 670 IT GOVERNANCE, RISK & COMPLIANCE

[3 Credits]

Prerequisite: None

This course provides an opportunity to explore IT governance, IT risk management, and regulatory compliance in depth. During the semester, we will study several interrelated topics, including the role of audit in IT and cybersecurity, IT regulations and compliance, the practice of business continuity planning, and the art and science of IT risk management. Students successfully completing this course will have a strong working knowledge of these topics and practices.

SEIS 709 ENTERPRISE ARCHITECTURE & STRATEGY

[3 Credits]

Prerequisite: None

This course provides students with a theoretical and practical understanding of Strategy and Enterprise Architecture (EA). It studies how EA enables organizations to effectively accomplish their business goals. Specifically, the course analyzes the relationships among business strategies, IT strategies, business, applications, information, and technology architectures. It also examines current industry trends such as: design thinking, digital transformation, cloud migration, and introduces students to EA implementation frameworks and tools.

SEIS 710 BLOCKCHAIN

[3 Credits]

Prerequisite: None

This course will examine the confluence of technologies that underpin blockchain-based distributed ledgers that first appeared in cryptocurrencies like Bitcoin. New terminology is introduced, followed by discussions regarding why this technology is disruptively powerful and a philosophical inquiry into the nature of money itself. The course breaks down the role of "mining" and demonstrates why the economics of the current implementations are not scalable (or even profitable). The process of building blocks one technology at a time from the underlying revision control system, the communication channel known as "gossip," to achieving consensus in both a trusted and untrusted world will be covered. Students will examine practical case studies beyond cryptocurrencies, which will include critical identification of when these technologies are not practical. Finally, the course will conclude with an in-depth exploration into Smart Documents and Smart Contracts and their possible outcomes.

SEIS 711 DISTRIBUTED LEDGER BASED SMART CONTRACTS

[3 Credits]

Prerequisite: None

It is important for St. Thomas to provide a course on smart contracts for various reasons. Smart contracts are an emerging technology that is gaining widespread attention and adoption. As a result, there is a growing demand for professionals who have the skills and knowledge to design and manage smart contracts. Also, a course on smart contracts can provide students with hands-on experience in areas such as programming, cryptography, and blockchain technology. Smart contracts are a high-growth field with many opportunities for career advancement. A search of indeed shows more than 200 jobs in this area in Minnesota, so there is a demand for experts. Smart contracts can be used to create a positive social impact by enabling new and different forms of cooperation and collaboration. For example, smart contracts can be used to create decentralized social networks, crowdfunding platforms, and peer-to-peer lending systems, which can help address social and environmental challenges.

SEIS 715 NETWORKING ARCHITECTURE & PROTOCOLS

[3 Credits]

Prerequisite: (601 & 603) and 663

This course examines the concepts, technology, and best practices involved in networking. There will be an emphasis on the IP networking protocols including TCP, UDP, ARP, DNS, SMTP, DHCP, HTTP, SSH, and TLS. We study protocol details, the way they relate and interact with each other, and how they are applied in real systems. Security vulnerabilities will be discussed as well as the roles of networking in both cloud, local, and hybrid environments will also be discussed.
Prerequisites SEIS 601 or SEIS 603; and SEIS 663

SEIS 732 DATA STORES AND FEATURE DESIGN

[3 Credits]

Prerequisite: SEIS 630 and SEIS 631

The real world is messy, and a data scientist's job will be to make sense of it. This course will dive into specialized data formats, such as time series, geospatial data, semi-structured and the data management systems and considerations required to load and extract information from them. Leveraging both creativity and context data scientists can design highly impactful features for machine learning applications by using SQL and Python to transform data. This course aims to provide hands-on experience working with these data formats and the power of developing novel metrics and features for analytics and machine learning. To do this effectively, this course will compare and contrast the conceptual designs of relational, data warehouse, NoSQL, and other data systems so that practitioners can utilize these systems to their fullest. Lastly, enterprises are investing heavily in data governance, data lineage, and metadata management to better preserve contextual information about their data. These systems will be covered as they will increasingly be required to enable disparate sources of information to be leveraged together and crucial for data scientists to build accurate and ethical models for deployment.

SEIS 735 AI CASE STUDY FOR HEALTHCARE

[3 Credits]

Prerequisites: 639

The healthcare data is inherently heterogeneous with numeric health records, semi-structural medical text, and medical images. This course will discuss how to apply the latest artificial intelligence approaches in analyzing different types of healthcare data. Real-world projects to be discussed in this course include (1) training artificial intelligence models to learn patterns from 16-million medical papers and doctors' notes for predicting potential disease outcomes, (2) analyzing patient health records to detect frequent medical sequences for treatment and prevention (3) applying machine vision methods in analyzing fish embryo images for identifying morphological changes due to toxic chemical exposure, (4) using deep-learning methods to analyze motions in telemedicine videos, (5) building clinic decision support systems to detect possible prescription errors, (6) querying databases on National Library of Medicine to enhance medical decisions, (7) imputing medical data with up to 95% missing values.

SEIS 739 SOFTWARE ANALYSIS, DESIGN, AND IMPLEMENTATION

[3 Credits]

Prerequisite: SEIS 602, 610 and 622

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 744 IoT WITH MACHINE LEARNING

[3 Credits]

Prerequisite: 601 or 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 745 DATA LAKE ENGINEERING

[3 Credits]

Prerequisite: (601 or 603) and 630

Individuals generate more data than ever before as they interact with websites, social platforms, streaming services, and increasingly data-driven industries like healthcare, retail, and energy. A growing number of connected devices continuously stream data using familiar web protocols and patterns. In our increasingly digital world, this data is dependent upon to drive artificial intelligence and automation in near real-time. Before data can be relied upon to drive AI, however, it must be integrated, carefully curated, and governed at scale. It falls on data engineers to bring together data from various sources and contextualize those datasets to produce intelligence. Massively distributed Data Lake platforms empower engineers to work with datasets at a volume and variety not suitable for traditional, relational databases. This hands-on course focuses on data collection, storage, and analysis on a cloud Data Lake architecture, covering both batch and streaming pipelines. Additionally, it explores NoSQL database paradigms that facilitate low-latency queries over

distributed and often unstructured or semi-structured datasets. Expect to learn fundamental concepts and gain practical experience working with different types of data, all within a reliable cloud lab environment.

SEIS 755 UI/UX DESIGN

[3 Credits]

Prerequisite: None

The course will introduce students to the methods and tools used in User Experience (UX) and User Interface (UI) design. UxDesign will provide an introduction to the foundation of each of the design stages of a product's lifecycle/journey and will provide a key understanding on the components required to ensure the end product will meet end user needs. Some of the topics discussed in the course include User Experience Design, Design Thinking, Human Centered Design, UxDesign techniques, such as: personas, user stories / user story mapping, storyboards, wireframing, UxDesign methods, such as: design methods, design prioritization, and rapid/interactive UI development; and coverage of key prototyping tools and software.

SEIS 756 AI FOR SMART MANUFACTURING I

[3 Credits]

Prerequisite: None

In this course, we will focus on foundational Smart Manufacturing (SM) and AI concepts necessary to build any SM system. We will journey through the history of SM and its applications and how modern ML and IoT systems can be adapted for SM applications. Students will also learn about basic data handling and simulation techniques used in the manufacturing industry. By leveraging real-world data from our industry partners, we will walk the tightrope between theory and application toward the realization of feasible SM systems.

SEIS 757 AI FOR SMART MANUFACTURING II

[3 Credits]

Prerequisite: SEIS 756

This course will build upon the foundational concepts introduced in SEIS 756 and introduce more advanced Smart Manufacturing (SM) and AI techniques. An introduction to deep neural network techniques and manufacturing process control will be provided. We will also learn about edge computing and quantization techniques for light weight deployment of deep learning algorithms. A more detailed look at manufacturing control systems, computer vision, and reinforcement learning will be covered. The course will cover practical concepts related to the development of SM systems through a term project.

SEIS 763 MACHINE LEARNING

[3 Credits]

Prerequisite: SEIS 631 and 632 (may take 632 concurrently with 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 765 MLOps

[3 Credits]

Prerequisite: SEIS 763

In the rapidly evolving landscape of machine learning and artificial intelligence, the efficient deployment, management, and monitoring of machine learning models are crucial for successful and sustainable outcomes. The Machine Learning Operations (MLOps) course is designed to equip participants with the knowledge and skills needed to bridge the gap between machine learning development and operational deployment. Through a comprehensive curriculum, hands-on labs, and real-world case studies, participants will learn the essential principles and practices that enable seamless collaboration between data scientists, machine learning engineers, and operations teams. This course covers key concepts, tools, and strategies used in MLOps, helping organizations streamline their machine learning pipelines and enhance the reliability, scalability, and maintainability of their models.

SEIS 766 VISION AI

[3 Credits]

Prerequisite: SEIS 764

This course offers an interactive learning experience that delves into how machines perceive, analyze, and react to images and visual cues. You'll gain a greater understanding of images, videos, and their processing algorithms through hands-on activities. By working on practical tasks like manipulating images and experimenting with Generative AI models like GANs, you'll discover the vast applications of Vision AI. Industries such as entertainment and healthcare are already benefiting from these technologies, which enable machines to recognize patterns, predict outcomes, and even create art. With this course, you'll learn both the theoretical and practical aspects of Vision AI, empowering you to combine your creativity with cutting-edge technology. At the end of this course, students will develop skill sets in visual intelligence and be poised to shape the future of this exciting field.

SEIS 767 CONVERSATIONAL AI

[3 Credits]

Prerequisite: SEIS 764

This course will explore the dynamic intersection of machine intelligence and human conversation. Throughout this course, you'll discover the profound practical benefits of Conversational AI. Businesses can revamp their approach to customer communication, leading to instant query resolution and increased customer loyalty. If you're inclined towards data, you'll appreciate how Conversational AI can simplify complex data sets, pulling out meaningful insights faster than ever. Consider the significant boost in productivity for general workplace scenarios when intuitive AI systems handle routine tasks, such as scheduling and information retrieval. We've structured this course to give you both a solid grounding in the theoretical aspects of Conversational AI and hands-on experience with its real-world applications. Whether you aim to refine customer interactions in a business setting, optimize data analysis, or enhance workplace productivity, this course promises to be transformative. Get ready to delve deep; by the end, students will be well-equipped to lead the charge in shaping the future of communication and productivity.

SEIS 779 INTERNSHIP

[0 Credits]

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

SEIS 785 TOPICS

Credits: variable Prerequisites: variable

Descriptions for a particular section and topic may be found on the GPS web site. Prerequisites: variable

SEIS 795 INDEPENDENT STUDY

Prerequisite: Instructor approval

Independent study allows students to explore a subject of interest outside of the current curriculum or a topic to explore in greater depth to enhance learning and expertise. Students are required to create an independent study project proposal under the supervision of a department faculty member. Approved and completed independent study projects may apply

as an elective in Graduate Software programs. Prerequisite: Department and instructor approval is required for registration. Contact the department to register.