2026-2027

GRADUATE ENGINEERING
DEPARTMENT OF SOFTWARE ENGINEERING & DATA SCIENCE
COURSE CATALOG

College of Engineering Graduate Student Services

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

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

Contents

Introduction

The College of Engineering Graduate Student Course Catalog is designed to help you make the most of your educational experience at the University of St. Thomas by providing information about programs and courses. Students are responsible for reading and understanding the program and course details herein. The contents of this handbook are subject to change without notice and should not be read as part of a contractual relationship.

Policies

Please see the policy handbook for details about the policies pertaining to graduate students.

Engineering Master's

Master's in Electrical and Computer Engineering

The Master of Science degree in Electrical and Computer 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 and Computer 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 and Computer 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 and Computer 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 and Computer 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

Power Systems Concentration

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.

Electrification and Sustainability Concentration

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.

Embedded and Intelligent Systems Concentration

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.

Circuits, Signals and Systems Concentration

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 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 from another University of St. Thomas MS College of Engineering program (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 506 Statistical Methods for Manufacturing Quality
- 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 (MSME) program prepares students to be successful in the broad areas of advanced design and analysis of mechanical systems. 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 2) for students who have a bachelor's degree in another STEM-related field. Students with a bachelor's degree in mechanical engineering select three courses from a list of core courses and select seven electives.

Students with a bachelor's degree in another STEM related field are required to take four graduate foundational mechanical engineering courses, three courses from the core course list, and three electives.

Subject areas within the MSME program include:

- Product development
- Manufacturing processes and statistical methods
- Advanced product design
- Thermal systems
- Polymer design
- Biomaterials in the design of medical devices
- Design of experiments
- Mechatronics
- Advanced engineering materials
- Finite element analysis
- Simulation and visualization of dynamic systems

To complete the requirements for the MSME, 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:

Total Courses (10 graduate courses or 30 credits): Complete three courses from the list of core courses and complete seven electives.

Core Courses:

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 507 Introduction to Systems Engineering
- ETLS 555 Advanced Product Design
- ETLS 591 Advanced Thermal Systems
- ETLS 640 Lean Six Sigma
- ETLS 660 Engineering Leadership
- ETLS 664 Propulsion Systems and Compressible Flow
- ETLS 701 Design of Experiments
- ETLS 723 Biomaterials in the Design of Medical Devices
- ETLS 774 Introduction to Mechatronics
- ETLS 776 Materials Design and Development
- ETLS 777 Finite Element Analysis
- ETLS 789 Simulation and Visualization of Dynamic Systems
- ETLS 810 Advanced Controls

Elective Courses:

Any class from the list below counts towards the elective requirement for the MSME:

- ETLS 501 Production and Operations Systems
- ETLS 504 Excellence in Operations
- ETLS 508 Systems Design
- ETLS 509 Verification and Validation
- ETLS 520 Design and Manufacturing in the Medical Device Industry
- ETLS 525 Engineering Economics
- ETLS 552 Supply Chain Synchronization
- ETLS 630 Sensors for IOT and Autonomy
- ETLS 652 Technology Forecasting and Risk Management
- ETLS 662 Computer Aided Manufacturing & Machining Optimization
- ETLS 675 Digital Signal Processing
- ETLS 676 Real Time DSP
- ETLS 678 Applications of AI in Engineering
- ETLS 679 Embedded & Cyber Physical Systems
- ETLS 703 Advanced Manufacturing Methods and Technology
- ETLS 744 Power Systems & Smart Grids
- ETLS 745 Power Systems Operations and Controls
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines & Vehicles
- ETLS 748 Renewable Energy Generation
- ETLS 753 Power System Protection & Relays
- ETLS 770 Automated Control of Manufacturing Processes
- ETLS 775 Polymers in Design
- ETLS 779 FEA in Manufacturing
- ETLS 790 Modeling and Simulation for Systems Engineering
- ETLS 858 Engineering Capstone
- ETLS 881 Engineering Project Credits
- ETLS 882 Engineering Project Credits

Courses from the list of core courses are allowed as electives if they were not already taken to satisfy the core requirement. Certain ETLS courses not on the list above may be taken as electives with the approval of the MSME program director. Certain courses from the Graduate Programs in Software (SEIS) may also be deemed acceptable as MSME electives with permission of the MSME program director and permission from the SEIS course instructor to enroll in the course.

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

Total Courses (10 graduate courses or 30 credits): Complete all four foundational courses, complete three courses from the list of core courses, and complete three electives.

Foundational Courses (to be completed first):

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

Core Courses:

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 507 Introduction to Systems Engineering
- ETLS 555 Advanced Product Design
- ETLS 591 Advanced Thermal Systems
- ETLS 640 Lean Six Sigma
- ETLS 660 Engineering Leadership
- ETLS 664 Propulsion Systems and Compressible Flow
- ETLS 701 Design of Experiments
- ETLS 723 Biomaterials in the Design of Medical Devices
- ETLS 774 Introduction to Mechatronics
- ETLS 776 Materials Design and Development
- ETLS 777 Finite Element Analysis
- ETLS 789 Simulation and Visualization of Dynamic Systems
- ETLS 810 Advanced Controls

Elective Courses:

Any class from the list below counts towards the elective requirement for the MSME:

- ETLS 501 Production and Operations Systems
- ETLS 504 Excellence in Operations
- ETLS 508 Systems Design
- ETLS 509 Verification and Validation
- ETLS 520 Design and Manufacturing in the Medical Device Industry
- ETLS 525 Engineering Economics
- ETLS 552 Supply Chain Synchronization
- ETLS 630 Sensors for IOT and Autonomy
- ETLS 652 Technology Forecasting and Risk Management
- ETLS 662 Computer Aided Manufacturing & Machining Optimization
- ETLS 675 Digital Signal Processing
- ETLS 676 Real Time DSP
- ETLS 678 Applications of AI in Engineering
- ETLS 679 Embedded & Cyber Physical Systems
- ETLS 703 Advanced Manufacturing Methods and Technology
- ETLS 744 Power Systems & Smart Grids
- ETLS 745 Power Systems Operations and Controls
- ETLS 746 Power Electronics
- ETLS 747 Electrical Machines & Vehicles
- ETLS 748 Renewable Energy Generation
- ETLS 753 Power System Protection & Relays
- ETLS 770 Automated Control of Manufacturing Processes
- ETLS 775 Polymers in Design
- ETLS 779 FEA in Manufacturing
- ETLS 790 Modeling and Simulation for Systems Engineering
- ETLS 858 Engineering Capstone
- ETLS 881 Engineering Project Credits
- ETLS 882 Engineering Project Credits

Courses from the list of core courses are allowed as electives if they were not already taken to satisfy the core requirement.

Certain ETLS courses not on the list above may be taken as electives with the approval of the MSME program director.

Certain courses from the Graduate Programs in Software (SEIS) may also be deemed acceptable as MSME electives with permission of the MSME program director and permission from the SEIS course instructor to enroll in the course.

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 College 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 671 Human Aspects of Technical Management
- ETLS 771 Materials Engineering

Master's in Systems Engineering

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 College 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.

Students can choose their focus in the program:

- Systems Engineering
- Industrial 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 with AI
- SEIS 739 Software Analysis, Design, and Implementation
- SEIS 640 Ethical Hacking with AI

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

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 with AI
- SEIS 739 Software Analysis, Design, and Implementation
- SEIS 640 Ethical Hacking with AI

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

Engineering Certificates

The St. Thomas College of Engineering offers eight 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 College 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' College 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 616 Computing in Every Classroom
- 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 College 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 College 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 College 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 and Computer 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 and Computer Engineering Program.

Graduate Certificate in Quality Engineering

The Graduate Certificate in Quality Engineering equips students with the specialized skills needed for process control, testing, and quality assurance, ensuring that products meet customer expectations and regulatory standards.

Designed for professionals seeking to specialize in quality control and process improvement, this certificate helps develop expertise in creating efficient systems that enhance product quality, minimize waste, and reduce costs. This certificate is ideal for students with career interests in diverse fields, including biomedical engineering, biopharmaceuticals, aerospace, electronics manufacturing, service industries and general manufacturing.

Students have the option to use coursework from their graduate certificate to continue in a M.S. in Mechanical Engineering, Manufacturing Engineering, Engineering Management, Systems Engineering, Regulatory Science, or Electrical and Computer Engineering degree offered through the College of Engineering at the University of St. Thomas.

Required Courses (6 graduate credits):

- ETLS 506 Statistical Methods for Manufacturing Quality
- ETLS 640 Lean Six Sigma
- ETLS 701 Design of Experiment

Elective Courses

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

- ETLS 551 Organizational Performance Excellence
- ETLS 722 Medical Device Quality Systems
- ETLS 513 Technical Communications
- ETLS 555 Advanced Product Design
- SEIS 631 Data Preparation and Analysis
- SEIS 632 Data Analytics and Visualization

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

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 College 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.

Engineering Micro-Credentials

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:

- ETLS 635 AI for Smart Manufacturing I
- ETLS 636 AI for Smart Manufacturing II

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 College 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.

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 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 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 635 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.

ETLS 636 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.

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 664 PROPULSION SYSTEMS AND COMPRESSION FLOW

[3 Credits]

This course will cover essential elements of propulsion systems including gas mixtures, combustion, compressible flow, supersonic nozzles, normal and oblique shock waves, inlets, fans, compressors, combustion chambers, turbines, and exhaust nozzles. Cycle analysis and performance of common propulsion systems including ramjets, turbojets, turbofans and turboprop engines. Chemical and electric rocket propulsion, rocket staging, and orbital mechanics. Prerequisites: ENGR 381 Thermodynamics or Equivalent

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 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: TIER 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: TIER 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 and Computer 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

[3 Credits]

Prerequisite: None

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, and thermal. The integrated laboratory has 4 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 dynamic system under study. Students also work on either a team or individual based simulation and visualization of dynamic 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]

Prerequisite: Internship Eligibility

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 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.

Software Engineering and Data Science Master's

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, and computer vision, 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
- SEIS 631 Data Preparation and Analysis
- SEIS 633 Agentic AI
- SEIS 651 AI Ethics
- SEIS 763 Machine Learning
- SEIS 764 Artificial Intelligence
- SEIS 765 AI Systems Engineering
- SEIS 766 Vision AI

- SEIS 767 Conversational AI
- SEIS 795 Independent Study OR one SEIS Approved Elective (see below)

Approved Electives:

- SEIS 606 Vibe Coding
- SEIS 615 Cloud Computing
- SEIS 630 Database Management Systems and Design
- SEIS 663 Introduction to Cybersecurity
- SEIS 709 Enterprise Architecture and AI Strategy
- SEIS 732* Data Warehousing (*only for students with database backgrounds)
- SEIS 745* Data Lake Engineering (*only for students with database backgrounds)
- SEIS 795 Independent Study

View the Graduate Programs in Software course catalog.

Master's in Data Science

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

Graduates of this program will have 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
- 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 Warehousing
- 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 the Graduate Programs in Software course catalog.

Master's in Information Technology

The M.S. in Information Technology prepares students to lead and innovate in the planning, development, and management of enterprise IT systems. Through a balanced blend of technical expertise and business acumen, students gain hands-on experience with IT infrastructure, and organizational information systems that support evolving business needs.

Graduates of this program will possess the practical and strategic skills necessary to design, implement, and maintain complex IT ecosystems. They will be equipped to safeguard information assets, manage digital transformation, and guide technology strategy. The program prepares students for impactful careers in roles such as IT architecture, project and program management, and technology leadership.

To complete the requirements for the M.S. in Information Technology, students must successfully complete 10 courses (30 graduate semester credits) with a GPA of at least 2.7.

Choose two electives (or three 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) toward 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
- SEIS 709 Enterprise Architecture and AI Strategy
- SEIS 627 Software Agile Processes
- SEIS 615 Cloud Computing
- SEIS 616 AI-Driven Cloud Infrastructure
- 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 the Graduate Programs in Software course catalog.

Master's in Software Engineering

The M.S. in Software Engineering prepares students to design, build, and manage modern software systems using industry-relevant tools and techniques. The program emphasizes software design, cloud-based systems, infrastructure automation, and database-driven applications, giving students the skills to engineer robust and scalable solutions.

Through hands-on coursework in programming, software analysis, DevOps, and web development, students gain a deep understanding of the full software development lifecycle. The curriculum also introduces emerging practices such as AI-assisted development, equipping graduates to collaborate with intelligent tools that enhance productivity and code quality. Graduates of this program are prepared to advance into roles in software development across a wide range of industries.

To complete the requirements for the M.S. in Software Engineering, students must successfully complete 10 courses (30 graduate semester credits) with a GPA of at least 2.7.

Choose two electives (or three electives if SEIS 601 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) toward 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 601 Foundations of Java I
- SEIS 602 Foundations of Java II
- SEIS 610 Software Engineering with AI
- SEIS 615 Cloud Computing
- SEIS 622 Web App Development
- SEIS 616 AI-Driven Cloud Infrastructure
- 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.

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 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.

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 Data Engineering

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 Data Engineering 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 Data Engineering. 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 Data Engineering, 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:

Four Required Courses:

- SEIS 630 Database Management Systems and Design
- SEIS 631 Data Preparation and Analysis
- SEIS 732 Data Warehousing
- 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
- SEIS 610 Software Engineering with AI
- SEIS 630 Database Management Systems and Design
- SEIS 627 Software Agile Processes

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
- 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:

Four Required Courses:

- SEIS 610 Software Engineering with AI
- SEIS 615 Cloud Computing
- SEIS 616 AI-Driven Cloud Infrastructure
- SEIS 667 Digital Transformation 2.0 with Generative AI

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

View the Graduate Programs in Software course catalog.

Graduate Certificate in Generative Artificial Intelligence

The Graduate Certificate in Generative 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 Generative 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 633 Agentic AI
- SEIS 765 AI Systems Engineering
- SEIS 766 Vision AI
- SEIS 767 Conversational AI

View the Graduate Programs in Software course catalog.

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.

Software Engineering and Data Science Course Catalog

SEIS 601 FOUNDATIONS OF JAVA I

[3 Credits]

Prerequisite: None

This foundational software development course focuses on fundamental programming concepts 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 control flow. We discuss object-oriented concepts, such as objects and classes, object instantiation and initialization, method implementation and invocation, interfaces, inheritance, and garbage collection. We will explore how AI assistance can enhance software development through code generation, debugging assistance, and test development. Students will apply these concepts by writing Java programs and unit tests. No prior programming experience is required.

SEIS 602 FOUNDATIONS OF JAVA II

[3 Credits]

Prerequisite: SEIS 601 or an equivalent

This intermediate-level software development course builds upon foundational programming concepts, delving into advanced topics and practical application. We will thoroughly explore abstract data type concepts, providing a deep understanding of data structures and their associated algorithms for algorithm analysis. Canonical implementations and framework-supplied alternatives, such as the JDK and other relevant frameworks, will be examined and utilized. To apply these concepts, we will develop software using the Java programming language, leveraging industry-standard tools. We will also utilize tools for software build management, configuration, and version control (e.g., Git), as well as unit and integration testing (e.g., JUnit). Furthermore, we will discuss multi-threading, memory management, refactoring, and advanced debugging techniques, equipping students with the skills necessary for robust software development. Throughout the course, we will explore how AI assistance can enhance the software development lifecycle. This includes leveraging AI for tasks such as code generation for repetitive patterns, intelligent debugging assistance to identify and resolve complex issues, and automated test development to ensure code reliability. We will also examine how AI can be used to analyze code complexity and suggest refactoring improvements. This course assumes a solid foundation in fundamental software development concepts, including the ability to use and understand the Java programming language. Prerequisite: SEIS 601 or an equivalent understanding of foundational software development concepts is required.

SEIS 603 FOUNDATIONS OF PYTHON

[3 Credits]

Prerequisite: None

This introductory software development course focuses on fundamental programming concepts. We will cover general problem-solving techniques, algorithm creation, data types, constants, variables, expressions, Boolean logic, control flow, and principles of object-oriented programming. Throughout the course, we will implement programs using the Python programming language, exploring its versatility as both an interpreted and a compiled language. Students will work with core data types such as numbers, strings, lists, dictionaries, and sets. They will learn how to use Python for data management, establishing a foundation for future endeavors in fields like data science and web development. Additionally, we will examine how AI-powered tools can enhance the learning and development of Python code. For instance, we will introduce AI-driven code completion and error detection tools to help students understand syntax and debug more effectively. We may also explore AI applications in data analysis and automation, demonstrating potential uses for Python skills. Finally, we will introduce PyTest for unit and integration testing. No prior programming experience in Python or any other programming language is required.

SEIS 606 VIBE CODING

[3 Credits]

Prerequisite: SEIS 601, SEIS 603 or instructor's permission

This course explores vibe coding, a novel approach to human–AI pair programming. Students will engage with advanced AI-powered development environments that integrate intelligent assistance directly into the programming workflow. Alongside coding projects, the course first reviews foundational software engineering concepts, including requirements elicitation and requirements refinement. Emphasis is then placed on design patterns, testing, documentation, and ethical and legal issues in AI-assisted coding, as well as best practices for collaborating with AI in real-time. Through lectures, labs, discussions, and a major project, students will develop both the technical and engineering skills necessary to critically and creatively integrate AI into modern software development practices.

SEIS 610 SOFTWARE ENGINEERING WITH AI

[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. In addition, students explore how emerging approaches such as vibe coding and AI-assisted development can be integrated into traditional software engineering practices.

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 AI-DRIVEN CLOUD INFRASTRUCTURE

[3 Credits]

Prerequisite: SEIS 615

Modern IT infrastructure is evolving rapidly, driven by automation, scalability, and intelligence. This course explores Artificial Intelligence for IT Operations (AIOps) and Infrastructure as Code (IaC), two transformative practices shaping the future of IT systems. Students will learn how organizations design, deploy, and manage cloud scale infrastructure using automation and AI driven insights. Through hands on labs and real-world scenarios, the course covers key tools, patterns, and workflows for building resilient, scalable systems. By the end, students will be equipped to implement IaC for automated provisioning and apply AIOps techniques to optimize operations in dynamic environments. Prerequisite: SEIS 615

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 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 DATA PREPARATION AND 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 633 AGENTIC AI

[3 Credits]

Prerequisite: None

Recent advances in Generative AI have changed artificial intelligence from systems that only make predictions into intelligent agents that can reason through tasks, plan actions, use software tools, and interact with complex digital environments. These agent-based AI systems are increasingly used in real-world applications such as virtual copilots, automated workflows, research assistants, operational monitoring tools, and enterprise decision-support systems. As these systems become more capable, they also introduce new challenges related to safety, control, transparency, and responsible use, which must be carefully addressed in both academic and professional settings. This hands-on course focuses on the practical design, development, evaluation, and governance of Agentic AI systems. Students will learn how to build intelligent agents that can reason about problems, retrieve and store information, call tools and application programming interfaces (APIs), and work within real-world technical and organizational constraints. The course emphasizes sound engineering practices, safety guardrails, and production-ready system design. By the end of the course, students will have practical experience working with modern Agentic AI tools, language models, vector databases, and containerized environments, and will be able to design and deploy agentic AI systems suitable for real-world and enterprise applications.

SEIS 640 ETHICAL HACKING WITH AI

[3 Credits]

Prerequisite: SEIS 601 or SEIS 603

This course introduces the core concepts of ethical hacking, with attention to how artificial intelligence is transforming the field. An ethical hacker assesses software security by identifying weaknesses and vulnerabilities in target systems, often using AI-driven tools for reconnaissance, anomaly detection, and penetration testing. An effective ethical hacker must understand network communications, software development, and operating system internals, while also recognizing how attackers may leverage adversarial AI for automated exploits. The course begins with a review of operating system design, covering process scheduling, input/output, memory management, file system design, security, and protection mechanisms. It also explores how AI can be applied to enhance monitoring, intrusion detection, and automated response. The course continues with hands-on actions performed by ethical hackers, such as injection attacks, broken authentication, security misconfigurations, and data exposure, while also exploring how AI can enhance these activities.

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 667 DIGITAL TRANSFORMATION 2.0 WITH GENERATIVE AI

[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 709 ENTERPRISE ARCHITECTURE AND AI STRATEGY

[3 Credits]

Prerequisite: None

This course addresses how organizations can create advantage by aligning Business Strategy, Enterprise Architecture, and Artificial Intelligence capabilities. Students learn how enterprise architecture provides the structure needed to drive strategy enablement through effective use of AI. The course examines the relationships among business strategy, the multiple layers of enterprise architecture, and AI strategy, including how AI can influence competitive positioning and operating models. Current industry trends such as digital transformation, cloud platforms, data governance, and responsible AI are integrated throughout. By the end of the course, students will be able to assess AI capabilities and design architectures and roadmaps that connect technical execution to strategic goals.

SEIS 732 DATA WAREHOUSING

[3 Credits]

Prerequisite: SEIS 630

In today's data-driven world, Data Scientists and Data Engineers must have a solid understanding of data warehousing concepts. Many of the most valuable data sets still reside in corporate data warehouses. While the fundamental principles of data warehousing have existed for decades, a growing number of companies are now migrating these workloads to the cloud. This course aims to provide students with hands-on experience using popular cloud-based tools and data formats to develop metrics and features for analytics and machine learning. To achieve this, the course will begin by exploring the design differences between relational systems and data warehouses. It will then delve into best practices and common challenges associated with working with data from various sources. Additionally, as enterprises increasingly invest in data governance, data lineage, and master and metadata management to preserve contextual information, these concepts will also be covered. Understanding these topics is essential for leveraging disparate sources of information effectively.

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: SEIS 603 and 630

A growing number of connected devices continuously stream data using familiar web protocols and patterns. In our increasingly digital world, this data is relied 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 763 MACHINE LEARNING

[3 Credits]

Prerequisite: SEIS 631

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 develops computational models that emulate intelligent behavior through learning, perception, and decision-making. With the advent of deep learning, AI systems now achieve state-of-the-art performance in domains such as computer vision, natural language processing, and sequential pattern recognition. This course provides a rigorous introduction to the design and training of artificial neural networks, including techniques for improving generalization and adapting models to new tasks. Students will gain hands-on experience in implementing and optimizing deep learning architectures, while also examining the theoretical foundations that govern their behavior. Emphasis is placed on evaluating model performance, diagnosing training challenges, and understanding the limitations and risks associated with deploying AI systems in real-world contexts.

SEIS 765 AI SYSTEMS ENGINEERING

[3 Credits]

Prerequisite: SEIS 767
Students can either take SEIS 767 concurrently or before SEIS 765.

Modern AI applications are not just models. They are complex software systems that combine machine learning, data pipelines, retrieval systems, infrastructure, and experimentation. Building reliable AI applications requires careful system design, operational tooling, and measurement. This course teaches how to design and build production AI systems. Students learn the architectural patterns used in industry to deploy machine learning models, large language models, and retrieval systems at scale. Topics include model serving, message queues, vector databases, ranking systems, prompt management, experimentation, monitoring, and scalable infrastructure. Through lectures, architecture workshops, and hands-on labs, students develop a practical toolbox for building AI systems and learn how to apply these tools when designing real world applications.

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]

Prerequisite: Internship Eligibility

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

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

[3 Credits]

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.