Required Computer Science (6 cr)

COMS	591	Computers in the Classroom (3)
COMS	592	Computer-based Instructional Systems I (3)

EDUCATIONAL TECHNOLOGY MS
(Alternate Plan Paper - 32 cr minimum)

The Master of Science degree in Education Technology is designed to prepare teachers, administrators, educational trainers and other interested individuals (1) to utilize microcomputers, digital video, the Internet, multimedia and other forms of media technology as resources for and delivery of instruction or training; (2) to serve as managers or coordinators of the uses of microcomputers, telecommunication, computer laboratories and related technology in educational and/or training settings and/or (3) to be developers of instructional materials including digital video and multi-media for the new technologies.

Required Educational Technology (15-20 cr)

LME	522	Design and Production of Educational Media (2)
LME	610	Introduction to Technology in Education (3)
LME	643	Instructional Systems Design (2)
LME	650	Technology Tour (1)
LME	661	Networking (2)
LME	677	Trends in Educational Technology (2)
LME	698	Internship (1-2)

Elective Courses

LME	624	Digital Production (2)
LME	628	Interactive Distance Learning (2)
LME	629	Electronic Communications (2)
LME	635	Media Services (4)
LME	691	Advanced Internet (2)

Required Computer Science (6-9 cr)

COMS	591	Computers in the Classroom (3)
COMS	592	Computer-based Instructional Systems I (3)

Elective Courses

COMS	593	Computer-based Instructional Systems II (3)

Required Research (3-4 cr)

LME	692	Research Methods (2)
LME	694	Alternate Plan Paper (1)

Elective Courses

LME	607	Library Strategies for Graduate Students (1)

Required Education (7-10 cr)

EDAD	681	Planning and Facilities Management (3)
EDFD	579	Grant Writing and Program Funding (4)

Elective Courses

CI	665	Curriculum Leadership (2)
CI	666	Interdisciplinary Curriculum (2)

***Required Subject Specialty (1-10 cr)**
May be taken in any discipline

Fifty percent of credits must be taken at the 600 level. While correct at press time, please contact the program director for current program requirements.

ENGINEERING MS

College of Science, Engineering & Technology
Electrical Engineering Department
S135 Trafton, 507-389-5747

Chair: Thomas Hendrickson, Ph.D.
Graduate Coordinator: Han-Way Huang, Ph.D.

Carl Guber, Ph.D., Thomas Hendrickson, Ph.D., Han-Way Huang, Ph.D., Rajiv Kapadia, Ph.D., Muhammad Khaliq, Ph.D., Paul Lindfors, Ph.D., Julio C. Mandojana, Ph.D., Ramakrishna Nair, Ph.D., George O'Clock, Ph.D., Claude Seigler, Ph.D.

Mechanical Engineering Department
E205 Trafton, 507-389-6383

Chair: Saeed Moaveni, Ph.D.
Graduate Coordinator: Jerzy Fiszdon, Ph.D.

Vance Brown, Ph.D., Mike Hennessy, Ph.D., Charles W. Johnson, Ph.D., Kirstie Plantenburg, Ph.D.

The Electrical Engineering Program and the Mechanical Engineering Program offer a (joined) Master of Science in Engineering degree program. Students in this program may choose to specialize in Electrical Engineering, Mechanical Engineering or a combination of the two called Mechatronics. The program is designed to serve the following: those engineers in business and industry who want to continue their formal engineering education at the postgraduate level; new engineering graduates who want to increase their depth of knowledge and develop an area of specialization; those graduates from other related science and engineering disciplines who want to broaden their backgrounds by pursuing Engineering studies at the graduate level.

Admission. Applicants must meet the general admission requirements of the College of Graduate Studies. A B.S. in Engineering or a closely related field from an accredited program with a minimum GPA of 3.0/4.0 is

required. Three letters of recommendation are also required from those familiar with the applicant's technical abilities.

Financial Assistance. A limited number of graduate teaching assistantships are available for those individuals with substantial laboratory experience in Mechanical or Electrical Engineering or collateral fields. Research assistantships may also from time to time be available to exceptional candidates. Half-time and quarter-time assistantships include tuition waivers. Application for financial assistance must be made by February 28 and announcements will be made prior to April 15 for the fall semester.

The MS program will provide general preparatory core courses and courses generally related to areas of specialization. The core curriculum consists of mathematical physics, math/stat/CS. Each program of study must contain two basic components: Core Courses and Specialization Courses.

ENGINEERING MS
(Thesis Plan - 32 cr)
(Alternate Plan Paper - 34 cr)

Required Core, All Options (13-15 cr)
MAT/STAT 500/600 Course (3-4)
COMS 500/600 Course (3-4)
PHYS 641 Mathematical Physics I (4)
EE 600 Design Method (3) OR
ME 601 Advanced Computation Methods in Engineering (3)

Required Option
Choose one of the following areas of specialization.

ELECTRICAL ENGINEERING OPTION
Required Electrical Engineering Design Specialization (13-20 cr)
Students will work with their committee to select suitable courses. The primary areas in the Electrical Engineering Specialization are Communications Systems, Control/Biomedical Systems, Digital Systems, Materials and Microelectronics, and Mechatronics. In consultation with an advisor, choose a sequence of courses and other electives from the following list of courses and graduate level courses from computer science.

EE	553	EE	587	EE	562
EE	571	EE	572	EE	575
EE	576	EE	579		
EE	580	EE	581	EE	584
EE	597	EE	601	EE	603
EE	611	EE	612	EE	613
EE	621	EE	622	EE	623
EE	632	EE	633	EE	642
EE	643	EE	651	EE	652
EE	663	EE	674	EE	677
EE	695	EE	691		

Required Thesis or Alternate Plan Paper
EE 694 APP (1)
EE 699 Thesis/Design (3-6)

MECHANICAL ENGINEERING OPTION
Required Mechanical Engineering Design Specialization (13-20 cr)
Students will work with their committee to select suitable courses. The primary areas of specialization are Solids/Structural Systems, Thermal/Fluid Systems and Mechatronics. In consultation with an advisor, choose electives from the following list of courses and others.*

ME	516	ME	520	ME	523
ME	525	ME	527	ME	529
ME	539	ME	543	ME	550
ME	562	ME	563	ME	572
ME	602	ME	612	ME	623
ME	633	ME	640	ME	651
ME	655	ME	669	ME	672
EE	612	EE	674	EE	677

*From other appropriate areas such as management, business administration and manufacturing.

Required Thesis or Alternate Plan Paper
ME 694 APP (1)
ME 699 Thesis/Design (3-6)

MECHATRONICS OPTION
Required Mechatronics Engineering Design Specialization (13-20 cr)
Students will work with their committee to select suitable courses from both Electrical and Mechanical Engineering courses listed above.

Required Thesis or Alternate Plan Paper
EE or ME 694 APP (1)
EE or ME 699 Thesis/Design (3-6)

General Requirements:
Each student must pass the comprehensive exam in order to graduate. The comprehensive exam will be held twice a year and each student has two opportunities to pass the exam. Students planning to take the written comprehensive exam must submit a completed Written Comprehensive Examination Request and Report form to the graduate coordinator. This request must be made two moths before the exam in each semester. Students must complete at least 24 credits before they can take the comprehensive exam.

COURSE DESCRIPTIONS

ELECTRICAL ENGINEERING

553 (3) Advanced Communication Systems Engineering
Fundamentals of RF, microwave, and optical communication systems. Advances information theory. Digital modulation techniques. Phase-lock loop receivers and frequency synthesizers. Characterization of digital transmission systems. Equalization. Synchronization. Coding. Data compression. Nonlinear system analysis.

Amplitude and phase distortion. AM-PM conversation. Intermodulation and cross-modulation. Advanced spread spectrum systems.

562 (4) Advanced Digital System
A study of finite state machine design, hardware description language, principles of instruction execution, instruction pipe lining, superscalar processor design, multiprocessor systems and memory system design. One design credit.

571 (3) Advanced Control Systems
Develops design and analysis techniques for continuous and discrete time control systems including pole placement, state estimation and optimal control.
Pre: EE 358 and 368

572 (3) Digital Signal Processing
Develops design and analysis techniques for discrete signals and systems via Z-transforms, Discrete Fourier Transforms, implementation of FIR and IIR filters. The various concepts will be introduced by the use of general and special purpose hardware and software for digital signal processing.
Pre: EE 341

575 (4) Integrated Circuit Engineering
Introduction to theory and techniques of integrated circuit fabrication processes, oxidation, photolithography, etching, diffusion of impurities, ion implantation, epitaxy, metallization, material characterization techniques, and VLSI process integration, their design and simulation by SUPREM.
Pre: EE 303 and 332

576 (4) Antennas, Propagation, and Microwave Engineering
Principles of electromagnetic radiation, antenna parameters, dipoles, antenna arrays, long wire antennas, Microwave antennas, Mechanisms of radiowave propagation, scattering by rain, sea water propagation, guided wave propagation, periodic structures, transmission lines, Microwave millimeter wave amplifiers and oscillators, MIC & MMIC technology.
Pre: EE 408

579 (3) Superconductive Devices
Magnetic and superconducting properties of materials, microscopic theory of superconductivity and tunneling phenomenon. Josephson and SQUID devices, survey of computer memories, memory cell and shift register, A/D converters and microwave amplifiers. Integrated circuit technology and high temperature superconductors.
Pre: EE 303

580 (1) Integrated Circuit Fabrication Laboratory
Introduction to integrated circuit fabrication processes, device layout, mask design, and experiments related to wafer cleaning, etching, thermal oxidation, thermal diffusion, photolithography, and metallization. Fabrication of basic integrated circuit elements pn junction, resistors, MOS capacitors, BJT and MOSFET in integrated form. Use of analytic tools for in process characterization and simulation of the fabrication process by SUPREM.
Pre: EE 4/575 or concurrent with 4/575

581 (1) VLSI Design Laboratory
Laboratory to accompany EE 484 VLSI design. Individual IC design projects will be assigned using IC layout tools and simulation software. Culminates in a group project fabricatable under MOSIS.
Pre: concurrent with EE 484

584 (4) VLSI Design
VLSI technology. MOS and Bipolar transistor theory, SPICE models. Transistor structure and IC fabrication processes; layout design rules. Custom CMOS/BICMOS logic design and layout topologies; cell layout/chip partitioning/clocking. Bipolar/MOS analog circuit design and layout. Group design project. Library research study.
Pre: EE 303 and 333

587 (3) RF System Engineering
Overview of wireless communication and control systems. Characterization and measurements of two-port RF-IF networks. Transmission lines. Smith chart. Scattering parameters. Antenna-preselector-pream; lifier interface. Radio wave propagation. Fading. RF transistor amplifiers, oscillators, and mixer/modulator circuits. Multiple access techniques. Transmitter/receiver design considerations SAW matched filters.

600 (3) Design Methods
Application of EE computer modeling and simulation tools. Design of experiments, Taguchi methods, automated data acquisition and analysis methods.

601 (3) Linear System Analysis
This course covers the analysis of continuous and discrete multivariate systems, linear models of stochastic and non-stochastic systems, and analog and digital sampled data systems. Issues examined include controllability, stability, observability, tensor properties, signal spectra, state equations, optimization, and computer simulation. A variety of case studies of advanced systems also examined.
Pre: BS EE including undergraduate level systems analysis course work

603 (3) Non-Linear System Analysis
This course covers the analysis of non-linear continuous and discrete systems and devices. Topics covered include non-linear circuit analysis, non-linear stochastic and non-stochastic system models, limit cycles, oscillations, stability, non-linear transfer functions, chaotic systems, and non-linear wave functions. Computer simulation will be utilized in conjunction with selected case studies in advanced

non-linear systems.
Pre: BS EE including undergraduate level systems analysis course work

611 (3) Computer Hardware Algorithms
Study of major paradigms used in the evaluation and execution of algorithms. Algorithm analysis will include complexity measure, hardware requirements, organization and storage system requirement.

612 (3) Computer Architecture Design
A treatment of computer architecture covering new technological developments, including details of multiprocessor systems. Special emphasis will be devoted to new concepts.

613 (3) Parallel Processors
Computer architecture for parallel processors designed for high computation rates. Primary emphasis is on image processing, pattern recognition, etc. Performance of various systems with regard to interconnect network, fault tolerance and programming.

621 (3) Advanced Engineering Electromagnetics
Wave equations, solutions, wave propagation and polarization, reflection and transmission, rectangular wave guides and cavities, strip line and microstrip lines, geometric theory of diffraction.
Pre: EE 350, or equivalent

622 (3) Microwave Engineering
Active and passive microwave devices, microwave amplifiers and oscillators, microwave filters, cavity resonators, microwave antennas, microwave receivers, microwave transmitters.
Pre: EE 350, or equivalent

623 (3) Radiation and Optical Electronics
Coherent and incoherent radiation, optical resonators, laser oscillators and amplifiers, propagation in optical fibers, integrated optical dielectric wave guides, semiconductor lasers, wave propagation in anisotropic, and non linear media, detection and noise.
Pre: EE 350, or equivalent

632 (3) Noise and Information Theory
Selected topics in the theory of probability and statistics. Spectral analysis. Rayleigh, Rician, Gaussian and Poisson processes. Noise figure. Signal-to-noise ratio requirements for analog and digital communications, remote sensing, radar and sonar. Random signals in linear and nonlinear systems. Signal-to-noise enhancement techniques. Source encoding. Shannon's theorems.

633 (3) Digital Communications
Digital communication system modulation techniques. A/D conversion. Additional noise sources from sampling and encoding. Error detection and correction. Speech encoding. Data compression. Data networks. Companding. Multiplexing. Packet switching. Performance of digital baseband. Digital Signal Processing. Digital system design trade-offs.

642 (3) Advanced Integrated Circuit Engineering
Principles of silicon integrated circuit fabrication processes and design limitations. Process modeling, crystal growth, oxidation, implantation, diffusion, deposition. Processing of bipolar and MOS devices and circuits. Photolithography and design rules. Introduction to GaAs technology. Use of SUPREME.
Pre: EE 4/575

643 (3) Advanced VLSI Design
Design and layout of passive and active electronic devices in silicon integrated circuits, both digital and analog. CMOS and bipolar circuit design principles will be developed. Assembly techniques and process control measurements and testing for yield control will be introduced.
Pre: EE 4/585

651 (3) Biomedical Engineering I
Mathematical modeling of living systems. Entropy and information. Thermodynamic constraints. Feedback and feedforward mechanisms in metabolic processes. Metabolic heat generation and loss. Energy flow in living systems. Atomic and molecular bonds in biological systems. Engineering analysis of the cardiovascular, renal, immune, endocrine and nervous systems; analysis of specific disease states.

652 (3) Biomedical Engineering II
Physiological transport phenomena (intercellular, intracellular and membrane transport), strength and properties of tissue, bioelectric phenomena, muscle contraction, cardiovascular and pulmonary mechanics, design of artificial organs, diagnostic tools, therapeutic techniques in the treatment of cancer, material compatibility problems in prosthetics, ethical dilemmas in biomedicine.
Pre: EE 651

663 (3) Advanced Communication Systems
Fundamentals of RF, microwave, millimeter wave, and optical communication systems. Link power budgets. Bandwidth constraints. Phase-locked loop receivers. Matched filters. Spread spectrum communication systems. Modulation formats. Comparison of active and passive sensing systems. Signal processing.

674 (3) Advanced Control Systems II
Develops analysis and design techniques for multivariable feedback systems. Definitions of poles and zeros of multivariable systems are established. Study of design methods such as LQG, Youla parametrization and H optimal control.
Pre: EE 471

677 (1-4) Individual Study
Regular courses offered on demand by agreement with individual faculty members on an individual basis.

691 (1-4) In-Service

694 (1) Alternate Plan Paper
Alternate Plan Paper preparation.

695 (1-5) Research
Thesis research.

699 (3-6) Thesis
Thesis preparation.

MECHANICAL ENGINEERING
**** For all 500/600 level courses, instructor consent may waive prerequisites ****

516 (3) Thermal/Fluid Systems Design
The application of the principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of selected energy systems of current interest, such as nuclear, solar, geothermal, and also conventional systems. Lecture and design projects.
Pre: ME 324, ME 329

518 (3) Mechanical Systems Design
The application of mechanics to the design and analysis of motion and force transmitting systems. Optimal design.
Pre: ME 417

520 (3) Computer Aided Engineering
Lectures and laboratory work on electronic computers and their application to engineering design problems. Computer-aided design and introduction to the use of advanced computer codes for engineering design and analysis.
Pre: ME 324, ME 417

523 (3) Intermediate Mechanics of Materials
Stresses and deformation of curved beams, beams on elastic foundations, indeterminate problems, torsion of noncircular bars, introduction to plates and shells, thick walled cylinders, failure theories.
Pre: ME 417

525 (3) Thermal Analysis and Control of Electronic Equipment
Thermal consideration in the design of heat-exchange equipment. Review of heat transfer modes; contact resistance; air handling. Numerical methods. Cooling techniques; fins, extended surfaces, cold plates, heat pipes, immersion cooling, thermoelectric coolers. Enhanced heat transfer.
Pre: ME 324

527 (3) Kinematics and Dynamics of Mechanisms
Computer-oriented methods of synthesis. Burmester's theory. Fixed and moving centrodes and their application to synthesis. Dynamics of mechanisms. Force and moment balancing of linkages.
Pre: ME 417

529 (3) Energy Conversion
Methods of energy conversion. Topics may include hydroelectric, geothermal, wind and solar power generation, as well as unconventional methods of energy conversion. Term design problems.
Pre: ME 324, ME 329

539 (3) Air Conditioning and Refrigeration
Refrigeration cycles and equipment, refrigeration properties, heating and cooling loads, psychometric analysis of air conditioning. Distribution of air conditioning medium and air quality as applied to design.
Pre: ME 324 ME 329

543 (3) Theory of Elasticity
Fundamental equations in three dimensions, plane stress and plane strain, flexure and torsion of bars of various shapes.
Pre: ME 417

550 (3) Finite Element Method
Energy method and residual approaches, 2D and 3D problems, in stress analysis, application to steady and transient heat flow, hydrodynamics, creeping flow, solution methods.
Pre: ME 323 and ME 324

562 (3) Vibrations
Free and forced vibration in linear single degree of freedom systems, design and analysis of multiple degree of freedom systems with and without damping, vibration of coupled systems.
Pre: ME 323, ME 341

563 (4) Automatic Controls
Analysis of control systems using the methods of Evans, Nyquist, and Bode. Improvement of system performance by feedback compensation. Introduction to digital control.
Pre: ME 341

572 (3) Intermediate Heat Transfer
Basic concepts; physical and mathematical models for heat and mass transfer. Applications to conductive, convective, radiative, and combined mode heat transfer.
Pre: ME 324

591 (1-4) In-Service
Individual studies of problems of special interest. Open only to advanced students.

597 (1-6) Internship

599 (1-6) Individual Study

601 (3) Advanced Computational Methods in Engineering
Numerical methods for solving linear systems of equations, solution of non-linear equations, data interpolation, numerical differentiation, numerical integration, numerical solution of ordinary and partial differential equations.

602 (3) Advanced CAE
Investigation, review, and application of emerging computer aided tools for engineering. Advanced FEA; optimization.

Pre: ME 323, 324

612 (3) Reinforced Polymers
Mechanics, materials analysis, fabrication, characterization, performance of Reinforce Polymers.
Pre: ME 303

623 (3) Experimental Stress Analysis
Review of elastic stress-strain relationships; application of fundamental concepts of static and dynamic strain measurements by electrical means; theory and use of resistance gages, strain gage circuits and recording instruments; rosette analysis. Introduction to photoelasticity.
Pre: ME 323

633 (3) Dynamics of Ground Vehicles
Theory and engineering principles of non-guided ground vehicles, both road and off-road. Analysis and evaluation of performance characteristics, handling behavior and ride quality. Emphasis is on fundamental principles and a unified method of approach to the analysis of various types of ground vehicles.
Pre: ME 341

640 (3) Advanced Design of Mechanical Devices
Systematic design of mechanisms, the creation of force functions, mechanisms with two or more degrees of freedom, systematic development of adjustable mechanisms, methods to achieve high speed in automatic machines.
Pre: ME 327

651 (3) Transport Phenomena
A survey of the transport of momentum, energy, and mass. Continuum approach. Equations of change. Applications.

655 (3) Advanced Fluid Mechanics
Detailed analysis of incompressible fluids, viscous/inviscid, laminar/turbulent and developing flows.
Pre: ME 321

665 (3) Combustion
Thermodynamics and chemical kinetics of combustion. Structure, propagation, and stability of flames. Environmental aspects.
Pre: ME 321, 329

669 (3) Advanced Energy Systems
Advanced selected topics in energy conversion, theory, design and applications. Individual projects dealing with various aspects of advanced energy systems and associated energy sources.
Pre: ME 324, 329

672 (3) Conduction Heat Transfer
Analytical and numerical techniques for analysis of problems involving steady-state and transient heat conduction in solids.
Pre: ME 324

677 (1-6) Individual Study

691 (4) In-Service

694 (1) Alternate Plan Paper Research

699 (1-4) Thesis

ENGLISH MA

ENGLISH EDUCATION MS

CREATIVE WRITING MFA

(DISCIPLINE-BASED)

College of Arts & Humanities
English Department
230 Armstrong Hall • 507-389-2117

Chair: Anne O'Meara, Ph.D.
Director of Graduate Study: Donna R. Casella, Ph.D.

John Banschbach, Ph.D., Suzanne Bunkers, Ph.D., Donna Casella, Ph.D., Terry Davis, MFA, William Dyer, Ph.D., Tina Edstam, Ph.D., Terrance Flaherty, Ph.D., Gwen Griffin, Ph.D., Kathy Hurley, Ph.D., Mary Susan Johnston, Ph.D., Danald Larsson, Ph.D., Nancy Mackenzie, DA, JoAnna Mink, D.A., Roland Nord, DA., Lisa Norris, MFA., Anne O'Meara, Ph.D., Dave Popowski, Ph.D., Kay Puttock, Ph.D., Richard Robbins, MFA, Roger Sheffer, D.A., Louisa Smith, Ph.D., Harry Solo, Ph.D., Stephen Stoynoff, Ph.D., Richard Terrill, MFA

English at Minnesota State University offers five graduate programs; each is designed to meet the needs of a particular audience, so each has its own entrance requirements, curriculum, reading list, comprehensive examination format, and thesis/alternate plan requirements. It is important that prospective students discuss which program best meets their needs with the department chair, the department director of graduate study, or the individual program director. Students may begin work any semester in any of the programs, except in the M.F.A. in Creative Writing, which admits each Fall.

Graduate Assistantships. Graduate teaching assistantships are available during the academic year to full-time students. Assistants receive $8,000 over two semesters and full tuition remission for up to 18 credits. For more information, contact the Department of English.

CREATIVE WRITING MFA

Contact: Richard Robbins, MFA
(Thesis Plan - 48 cr)

The M.F.A. program in Creative Writing meets the needs of students who want to strike a balance between the development of individual creative talent and the close study of literature and language. Candidates in the program will find it appropriate training for careers in freelance writing, college-level teaching, editing and publishing, arts administration, and several other areas.