Technology Systems Management

(Administered by the Department of Agricultural and Biosystems Engineering)

Undergraduate Study

The Department of Agricultural and Biosystems Engineering offers work for the bachelor of science degree with majors in agricultural systems technology and industrial technology.

Missions

The mission of the Agricultural Systems Technology program is to prepare women and men for careers that integrate and apply agricultural and biosystems engineering technology to manage human and natural resource systems for producing, processing, and marketing food and other biological products worldwide.

The mission of the Industrial Technology is to prepare women and men for careers that integrate and apply industrial technology to lead and manage human, manufacturing, and safety systems.

Objectives

At two to five years after undergraduate graduation, through the professional practice in technology, graduates should:

1. Have demonstrated competence in methods of analysis involving use of mathematics, fundamental physical and biological sciences, technology, and computation needed for the professional practice in the field of agricultural systems technology or industrial technology.

2. Have developed skills necessary to contribute to the design process; including the abilities to think creatively, to formulate problem statements, to communicate effectively, to synthesize information, and to evaluate and implement problem solutions.

3. Be capable of addressing issues of ethics, safety, professionalism, cultural diversity, globalization, environmental impact, and social and economic impact in professional practice.

4. Have demonstrated continuous professional and technical growth, with practical experience, so as to be licensed in their field or achieve that level of expertise, as applicable.

5. Have demonstrated the ability to:

a. be a successful leader of multi-disciplinary teams.

b. efficiently manage multiple simultaneous projects.

c. work collaboratively.

d. implement multi-disciplinary systems-based solutions.

e. to apply innovative solutions to problems through the use of new methods or technologies.

f. contribute to the business success of their employer, and

g. build community.

Outcomes

At the time of graduation, students of the Agricultural Systems Technology or Industrial Technology programs should have:

a) an ability to apply knowledge of mathematics, science, technology, and applied sciences;

b) an ability to design and conduct experiments, as well as to analyze and interpret data;

c) an ability to formulate or design a system, process or program to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

d) an ability to function on multi-disciplinary teams;

f) an understanding of professional and ethical responsibility;

g) an ability to communicate effectively;

h) the broad education necessary to understand the impact of solutions in a global, economic, environmental, and societal context;

i) a recognition of the need for, and an ability to engage in life-long learning;

j) a knowledge of contemporary issues; and

k) an ability to use the techniques, skills, and modern scientific and technical tools necessary for professional practice.

Graduates have developed and demonstrated workplace competencies, and have completed a professional internship. They are able to communicate effectively, have problem-solving skills and awareness of global, economic, environmental and societal issues.

Agricultural Systems Technology graduates have the ability to apply science and technology to problems related to agriculture; they manage complex agricultural systems for sustainability. They find careers within a variety of agriculturally-related industries, businesses, and organizations, including: agricultural machinery, environment, government, farm builders, grain, feed, seed, fertilizer, chemical, food, biorenewable resources, and production agriculture.

Industrial Technology graduates understand commonly-used manufacturing processes, lean manufacturing principles, continuous improvement, quality management, safety, regulatory issues affecting manufacturing, and the properties of manufacturing materials. They find careers within a variety of industries, businesses, and organizations focusing in manufacturing (e.g., quality control, production supervision, and process and facility planning) or occupational safety (e.g., development, management, and evaluation of safety programs and systems; and hazard identification and mitigation).

Certificate in occupational safety

The Department of Agricultural and Biosystems Engineering offers a undergraduate certificate in occupational safety which may be earned by completing a minimum of 20 credits of technology systems management courses, which includes:

TSM 270	Principles of Injury Prevention	3
TSM 370	Occupational Safety	3
TSM 371	Occupational Safety Management	2
TSM 372	Legal Aspects of Occupational Safety and Health	2
TSM 470	Industrial Hygiene: Physical, Chemical, and Biological Hazards	3
6 credits from a departmentally approved list		6
TSM 493D	Workshop in Technology: Occupational Safety (Note: This course needs to be the last course taken toward completion of the Occupational Safety Certificate)	1-4

Graduate Study

The department offers work for the degrees master of science, and doctor of philosophy with a major in industrial and agricultural technology. It cooperates in the interdepartmental programs in professional agriculture, sustainable agriculture, environmental sciences, biorenewable resources and technology, and human computer interaction.

The master's program prepares advanced practicing professionals for industrial and/or agricultural technology positions in industry, business, and public service; it also provides a sound foundation for further graduate study. The doctoral program prepares exemplary industrial and/or agricultural technology professionals for learning, discovery, engagement, and leadership roles in education, industry, business, and public service organizations.

The department also offers work for the degrees master of science, master of engineering, and doctor of philosophy with a major in agricultural engineering. See College of Engineering, Curricula.

Visit our departmental website at www.abe.iastate.edu

Courses primarily for undergraduates:

TSM 110. Introduction to Technology.
(1-0) Cr. 1. F. *Prereq: AST and I Tec majors only or permission of instructor*
Team-oriented introduction to agricultural systems technology and industrial technology. Internships, careers, competencies, academic success strategies, industry visits, transition to academic life.

TSM 111. Experiencing Technology.
(0-2) Cr. 1. S. *Prereq: AST or I Tec majors only or permission of instructor*
Laboratory-based, team-oriented experiences in a spectrum of topics common to the practice of technology. Report writing, internships, competencies, industry visits.

TSM 115. Solving Technology Problems.
(2-2) Cr. 3. F.S. *Prereq: MATH 140 or higher (can be taken concurrently)*
Solving technology problems and presenting solutions through technical reports. Unit conversions, unit factor method, SI units, significant digits, graphing and curve fitting. Use of spreadsheet programs to solve and present technology problems.Solution of technology problems using computer programming languages.

TSM 116. Introduction to Design in Technology.
(2-2) Cr. 3. F.S.
2D projections and 3D representations of objects, national and international standards for documentation, manufacturing processes, design projects, and teamwork. Free-hand sketching techniques and parametric solid modeling will be covered.

TSM 201. Preparing for Workplace Seminar.
(Cross-listed with BSE, A E). (1-0) Cr. 1. F.S. *Prereq: Sophomore classification in A E, AST, BSE or ITec*
8 week course. Professionalism in the context of the engineering/technical workplace. Development and demonstration of key workplace competencies: teamwork, initiative, communication, and engineering/technical knowledge. Resumes, interviewing, preparation for internship experiences, professional portfolios.

TSM 210. Fundamentals of Technology.
(3-0) Cr. 3. F.S. *Prereq: TSM 115 or equivalent, MATH 140 or higher*
Introduction to problem solving related to fundamental agricultural and/or industrial technology systems: Basic laws of energy, force, and mass, and their application in simple mechanical systems and thermal systems. Mathematical tools needed for data analysis. Introduction to modern information technology: GPS and Internet, their basic framework and implementations. Introduction to engineering economics: using the time value of money to make economic decisions.

TSM 216. Advanced Technical Graphics, Interpretation, and CAD.
(2-2) Cr. 3. F.S. *Prereq: TSM 116*
Advanced design systems incorporating 2D and 3D design and productivity tools for use in manufacturing settings. Topics include: Geometric Dimensioning and Tolerancing, 3D models, welding symbols, advanced visualization, design modeling of parts and assemblies, feature based design. Use of AutoCAD and parametric modeling software.

TSM 240. Introduction to Manufacturing Processes.
(1-4) Cr. 3. F.S.
A study of selected materials and related processes used in manufacturing. Lecture and laboratory activities focus on materials, properties, and processes. This includes plastics and metals.

TSM 270. Principles of Injury Prevention.
(3-0) Cr. 3. F.
Basic foundations of injury causation and prevention in home, motor vehicle, public, and work environments.

TSM 310. Total Quality Improvement.
(3-0) Cr. 3. S. *Prereq: STAT 101 or STAT 104, junior classification*
Introduction to the fundamental concepts of TQM - Deming style of management, statistical studies to understand the behavior of products, processes, or services, and how to define and document processes and customer focus. Introduction to continuous improvement tools and methods - DMAIC, SPC, and Lean, Six Sigma, and JIT; emphasis on team work and problem solving skills.

TSM 322. Preservation of Grain Quality.
(2-0) Cr. 2. S. *Prereq: MATH 140 or higher*
Principles and management for grain quality preservation. Quality measurement. Drying and storage. Fans and airflow through grain. Handling methods.

TSM 322L. Preservation of Grain Quality Laboratory.
(0-3) Cr. 1. S. *Prereq: Credit or enrollment for credit in TSM 322*
Hands-on experiences in the principles and management for grain quality preservation. Quality measurement. Drying and storage. Fans and airflow through grain. Handling methods. System planning. Industry tour.

TSM 324. Soil and Water Conservation Management.
(2-2) Cr. 3. S. *Prereq: MATH 140 or MATH 160*
Introduction to engineering and conservation principles applied to the planning of erosion control systems, water control structures, water quality management, and drainage and irrigation systems.

TSM 325. Biorenewable Systems.
(Cross-listed with A E, AGRON, AN S, BSE, BUSAD, ECON). (3-0) Cr. 3. F.
Prereq: ECON 101, CHEM 163 or higher, MATH 140 or higher
Converting biorenewable resources into bioenergy and biobased products. Biorenewable concepts as they relate to drivers of change, feedstock production, processes, products, co-products, economics, and transportation/logistics.

TSM 327. Animal Production Systems.
(3-0) Cr. 3. F. *Prereq: TSM 210*
Confined animal feeding operations. Environmental controls for animal production. Response of animals to the environment. Heat and moisture balance in animal housing. Ventilation, water, feed handling, air pollution, odor and waste management systems.

TSM 330. Agricultural Machinery and Power Management.
(2-3) Cr. 3. S. *Prereq: TSM 210, MATH 142 or MATH 160*
Selection, sizing, and operational principles of tractors and machinery systems. Cost analysis and computer techniques applied to planning and management of agricultural machine systems. Principles, operation, and application of agricultural machinery.

TSM 333. Precision Farming Systems.
(2-2) Cr. 3. F. *Prereq: MATH 140 or MATH 142, junior or senior classification*
Geographic information systems (GIS) and global positioning systems (GPS). Hardware systems for precision farming emphasized. Autosteering and automatic implement control systems. Collection and management of yield data. Sampling strategies for precision farming. Introduction to building fertilizer prescriptions and recommendations. Economic benefits of precision farming systems. Nonmajor graduate credit.

TSM 335. Tractor Power.
(3-3) Cr. 4. F. *Prereq: TSM 210, MATH 142*
Theory and construction of tractor engines, mechanical power trains and hydraulic systems. Introduction to traction, chassis mechanics, and hydraulic power.

TSM 337. Fluid Power Systems Technology.
(2-2) Cr. 3. S. *Prereq: TSM 210*
Fundamental fluid power principles. Fluid properties. Function and performance of components such as pumps, valves, actuators, hydrostatic transmission. Analysis of fluid power circuits and systems. Introduction to electrohydraulics. Course includes lab using fluid power trainers.

TSM 340. Advanced Automated Manufacturing Processes.
(2-2) Cr. 3. F. *Prereq: TSM 216, TSM 240, MATH 142*
NC programming operations for CNC mills and lathes. Transfer of parts descriptions into detailed process plans, tool selection, and NC codes. Computer assisted CAD/CAM NC programming for 2D/3D machining.

TSM 363. Electric Power and Electronics for Agriculture and Industry.
(3-3) Cr. 4. S. *Prereq: TSM 210*
Basic electricity. Electrical safety, wiring, 3-phase service, controls, and motors for agricultural and industrial applications. Planning building lighting and electrical systems. Electronics to sense, monitor, and control mechanical processes. Nonmajor graduate credit.

TSM 370. Occupational Safety.
(3-0) Cr. 3. S. *Prereq: TSM 270, junior standing*
Identifies safety and health risks in industrial work environments. Focus on how managers and supervisors meet their responsibilities for providing a safe workplace for their employees. Includes the identification and remediation of workplace hazards. Nonmajor graduate credit.

TSM 371. Occupational Safety Management.
(2-0) Cr. 2. S.
Introduction to occupational safety and health administration and management. Focus on development and management of safety programs and obtaining employee involvement in occupational safety programs.

TSM 372. Legal Aspects of Occupational Safety and Health.
(2-0) Cr. 2. Alt. F., offered 2013. *Prereq: TSM 371*
A review of the common legal issues facing safety practitioners in the workplace. Includes OSHA, EPA and DOT regulations; workers' compensation, as well as common liability issues.

TSM 376. Fire Protection and Prevention.
(3-0) Cr. 3. Alt. F., offered 2012.
An overview of the current problems and technology in the fields of fire protection and fire prevention, with emphasis on industrial needs, focusing on the individual with industrial safety responsibilities.

TSM 393. Topics in Technology.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393A. Topics in Technology: Agriculture and Biosystems Management.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393B. Topics in Technology: Machine Systems.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393C. Topics in Technology: Manufacturing.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393D. Topics in Technology: Occupational Safety.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393E. Topics in Technology: Chemical Application Systems.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393F. Topics in Technology: Agricultural Safety and Health.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393G. Topics in Technology: Electronic Integration for Agriculture and Production Systems.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393I. Topics in Technology: Irrigation Systems Management.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 393J. Topics in Technology: Machinery Management Using Precision Agriculture Technology.
Cr. 1-4. F.S.SS.
Offered as demand warrants. Web-based instruction.

TSM 397. Internship in Technology.
Cr. R. F.S.SS. *Prereq: At least 45 credits of coursework, in AST or I Tec major, and approval of internship coordinator*
A supervised work experience in an approved learning setting with application to technology practices and principles. Reporting during work experience and self and employer evaluation required. Minimum GPA requirement.

TSM 399. Work Experience in Technology.
Cr. 2. Repeatable, maximum of 4 credits. F.S.SS. *Prereq: TSM 397 the preceding semester and approval of internship coordinator*
Written reports and reflection on work experience. A maximum of 4 credits of TSM 399 maybe be used toward the total credits required for graduation.

TSM 415. Technology Capstone I.
(0-2) Cr. 1. F.S. *Prereq: senior classification with less than 32 credits remaining*
Identification and proposal development of a current technological problem in agricultural or industrial systems. Formation of project teams and selection of faculty project mentor in preparation to complete project.

TSM 416. Technology Capstone II.
(1-8) Cr. 5. F.S. *Prereq: TSM 415 in previous semester*
Continued team development, communications, and responsibilities. Development of alternate solutions using creativity, critical analysis, and planning techniques. Selection of promising potential solutions to technology problems identified in TSM 415 for development and analysis by student teams. Presentation of project through oral presentations, written reports, and working prototypes.

TSM 440. Cellular Lean Manufacturing Systems.
(2-2) Cr. 3. F.S. *Prereq: TSM 310*
Introduction to lean tools and techniques that reduce costs and improve business performance: JIT, VSM, SMED, Kaizen, Standard Work, Cycle Time Reduction, Takt Time, A3, etc. Emphasis on lean thinking and competency development through application: simulations, case studies, industry guests and mentors, teamwork and industry-related lean projects.

TSM 443. Statics and Strength of Materials for Technology.
(2-2) Cr. 3. S. *Prereq: PHYS 111, MATH 142 or MATH 165*
Application of standard analytic and computer based techniques of solving problems related to force and moments. The properties of materials and how to select appropriate materials for a particular design is reviewed.

TSM 444. Facility Planning.
(3-0) Cr. 3. F. *Prereq: TSM 216 and TSM 240; STAT 101 or STAT 104*
Principles and practices in designing, evaluating, and organizing existing facilities or creating new facilities. Emphasis on AutoCAD-based new facility design project - product design, production flow analysis, activity relationship analysis, layout deployment, materials handling, office and other service requirement design, and the necessary cost analysis for the new facility.

TSM 465. Automation Systems.
(2-2) Cr. 3. S. *Prereq: TSM 363*
Theory and applications of automation systems. Emphasizes features, capabilities, design and programming skills of Programmable Logic Controller (PLC) based industrial control systems. Introduction to industrial robots and sensors.

TSM 470. Industrial Hygiene: Physical, Chemical, and Biological Hazards.
(3-0) Cr. 3. Alt. S., offered 2012. *Prereq: MATH 160 or higher*
A qualitative and quantitative introduction to health effects of chemical, biological, and physical hazards in a workplace. Nonmajor graduate credit.

TSM 471. Safety Laboratory.
(0-2) Cr. 1. Alt. S., offered 2012. *Prereq: TSM 470 (can be taken concurrently)*
Introduction to equipment, methods, and strategies to measure, evaluate, control, and research hazards and risk in the workplaces.

TSM 477. Risk Analysis and Management.
(Dual-listed with TSM 577). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: MATH 160, STAT 101 or STAT 104*
Risk analysis and management focuses on developing a risk oriented pattern of thinking that is appropriate for today's complex world. The tools that will be gained in this course will be helpful in recognizing, understanding, and analyzing hazards and risks in modern complex systems.

TSM 490. Independent Study.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 490H. Independent Study: Honors.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 490I. Independent Study: Manufacturing.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 490J. Independent Study: Agriculture and Biosystems Management.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 490M. Independent Study: Machine Systems.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 490O. Independent Study: Occupational Safety.
Cr. 1-4. Repeatable. *Prereq: Junior or senior classification, permission of instructor, and completion of an independent study contract and approval by department*
A maximum of 4 credits of TSM 490 may be used toward the total credits required for graduation.

TSM 493. Workshop in Technology.
Cr. 1-4. Repeatable.
Offered as demand warrants.

TSM 493A. Workshop in Technology: Agriculture and Biosystems Management.
Cr. 1-4. Repeatable.
Offered as demand warrants.

TSM 493B. Workshop in Technology: Machine Systems.
Cr. 1-4. Repeatable.
Offered as demand warrants.

TSM 493C. Workshop in Technology: Manufacturing.
Cr. 1-4. Repeatable.
Offered as demand warrants.

TSM 493D. Workshop in Technology: Occupational Safety.
Cr. 1-4. Repeatable.
Offered as demand warrants.

TSM 496. Technology Travel Course.
Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international industrial technology and/or agricultural systems technology industries. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C; or option D.
Meets International Perspectives Requirement.

TSM 496A. Technology Travel Course: Pre-departure.
Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international industrial technology and/or agricultural systems technology industries. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C; or option D.
Meets International Perspectives Requirement.

TSM 496B. Technology Travel Course: Travel.
Cr. R. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international industrial technology and/or agricultural systems technology industries. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C; or option D.
Meets International Perspectives Requirement.

TSM 496C. Technology Travel Course: Post-travel.
Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international industrial technology and/or agricultural systems technology industries. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C; or option D.
Meets International Perspectives Requirement.

TSM 496D. Technology Travel Course: Combination (Pre-departure, Travel, and Post-travel).
Cr. 1-4. Repeatable. F.S.SS. *Prereq: Permission of instructor*
Limited enrollment. Tour and study of international industrial technology and/or agricultural systems technology industries. Location and duration of tours will vary. Travel expenses paid by students. Course requires completion of options A, B, and C; or option D.
Meets International Perspectives Requirement.

Courses primarily for graduate students, open to qualified undergraduates:

TSM 540. Advanced Design and Manufacturing.
(3-0) Cr. 3. S. *Prereq: Permission of instructor*
Application of six sigma philosophy to advance product design and process control. Application of value steam mapping to the existing manufacturing system to develop future continuous improvement plans. Application of Taguchi Parameter design methodologies for optimizing the performance of manufacturing processes. Application of Taguchi Tolerance Design methodologies for product design.

TSM 575. Safety and Public Health Issues in Modern Society.
(2-0) Cr. 2. Repeatable, maximum of 2 times.
Exploration and analysis of current safety and public health issues impacting society. The focus will be on topics that impact individuals in work, public, and home environments.

TSM 577. Risk Analysis and Management.
(Dual-listed with TSM 477). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: MATH 160, STAT 101 or STAT 104*
Risk analysis and management focuses on developing a risk oriented pattern of thinking that is appropriate for today's complex world. The tools that will be gained in this course will be helpful in recognizing, understanding, and analyzing hazards and risks in modern complex systems.

TSM 590. Special Topics in Technology.
Cr. 1-4. Repeatable, maximum of 4 credits. *Prereq: Graduate classification in industrial and agricultural technology, permission of instructor, and completion of an independent study contract approved by major professor*

TSM 590A. Special Topics in Technology: Agriculture and Biosystems Management.
Cr. 1-4. Repeatable, maximum of 4 credits. *Prereq: Graduate classification in industrial and agricultural technology, permission of instructor, and completion of an independent study contract approved by major professor*

TSM 590B. Special Topics in Technology: Machine Systems.
Cr. 1-4. Repeatable, maximum of 4 credits. *Prereq: Graduate classification in industrial and agricultural technology, permission of instructor, and completion of an independent study contract approved by major professor*

TSM 590C. Special Topics in Technology: Manufacturing.
Cr. 1-4. Repeatable, maximum of 4 credits. *Prereq: Graduate classification in industrial and agricultural technology, permission of instructor, and completion of an independent study contract approved by major professor*

TSM 590D. Special Topics in Technology: Occupational Safety.
Cr. 1-4. Repeatable, maximum of 4 credits. *Prereq: Graduate classification in industrial and agricultural technology, permission of instructor, and completion of an independent study contract approved by major professor*

TSM 593. Workshop in Technology.
Cr. 1-3. Repeatable. *Prereq: Permission of instructor*

TSM 598. Technical Communications for a Master's Degree.
(Cross-listed with A E). Cr. 1. F.S.SS.
A technical paper draft based on the M.S. thesis or creative component is required of all master's students. This paper must be in a form that satisfies the requirements of some specific journal and be ready for submission. A technical presentation based on M.S. thesis or creative component is required of all master's students. This presentation must be in a form that satisfies the normal presentation requirements of a professional society. The presentation itself (oral or poster) may be made at a professional society meeting or at any international, regional, state, or university conference/event as long as the presentation content and form conforms to normal expectations. Offered on a satisfactory-fail basis only.

TSM 599. Creative Component.
Cr. 1-3. Repeatable, maximum of 6 credits.
A discipline-related problem to be identified and completed under the direction of the program adviser. Three credits required for all nonthesis master's degree students.

Courses for graduate students:

TSM 601. Graduate Seminar.
(Cross-listed with A E). (1-0) Cr. 1. F.
Keys to writing a good MS thesis or PhD dissertation. How to begin formulating research problems. Discussion of research problems and broader impacts, review of literature, identifying knowledge gaps and needs, long-term goals, research hypotheses, objectives, rationale and significance, methods, procedures, data analysis, and reporting results. Presentation of research proposal in different formats. Using peer review and responding to feedback.

TSM 652. Program and Learner Evaluation.
(3-0) Cr. 3. *Prereq: STAT 401 or equivalent*
Techniques for evaluating learners, facilities, programs, and staff utilizing theories for developing measurement instruments. Outcomes assessment is emphasized.

TSM 655. Academic Leadership in Technology and Engineering.
(3-0) Cr. 3. *Prereq: Permission of instructor*
A definition of the faculty role in technology and engineering disciplines, including strategies for dealing with programs, personnel, and constituencies are presented. Leadership skills involving team formation, team operation, and conflict resolution are addressed.

TSM 657. Curriculum Development in Technology and Engineering.
(3-0) Cr. 3. *Prereq: Permission of instructor*
Basic concepts, trends, practices, and factors influencing curriculum development, techniques, organization and procedures. Emphasis will be given to program and course development.

TSM 694. Teaching Practicum.
(Cross-listed with A E). Cr. 1-3. Repeatable. F.S.SS. *Prereq: Graduate classification and permission of instructor*
Graduate student experience in the agricultural and biosystems engineering departmental teaching program.

TSM 697. Internship in Technology.
Cr. R. *Prereq: permission of major professor and approval by department chair, graduate classification*
One semester and one summer maximum per academic year professional work period. Offered on a satisfactory-fail basis only.

TSM 698. Technical Communications for a Doctoral Degree.
(Cross-listed with A E). Cr. 1. F.S.SS.
A technical paper draft based on the dissertation is required of all Ph.D. students. This paper must be in a form that satisfies the requirements of some specific journal and be ready for submission. A technical presentation based on the dissertation is required of all Ph.D. students. This presentation must be in a form that satisfies the normal presentation requirements of a professional society. The presentation itself (oral or poster) may be made at a professional society meeting or at any international, regional, state, or university conference/event as long as the presentation content and form conforms to normal expectations. Offered on a satisfactory-fail basis only.

TSM 699. Research.
Cr. arr.