

# INDUSTRIAL TECHNOLOGY

The Department of Agricultural and Biosystems Engineering offers a bachelor of science degree in Industrial Technology (ITec), as well as an undergraduate certificate in Occupational Safety. Students majoring in ITec choose between two options: Manufacturing or Occupational Safety. The department also offers a minor in Industrial Technology.

Successful ITec graduates gain knowledge, skills, and abilities in solving technical problems, understanding the design process, excelling in authentic leadership, being aware of safety issues, having a quality orientation, effectively managing projects, and having a systems-thinking perspective. This translates to a holistic approach that uses science and engineering principles to focus on the way the constituent parts of a manufacturing system interrelate, how they work over time, and how they fit the context of larger systems. Graduates find careers within a variety of industries, businesses, and organizations in the fields of advanced manufacturing; robotics; automation and controls; electronics; lean manufacturing; quality management; safety management, loss prevention; or industrial hygiene.

Common job duties of ITec Manufacturing graduates include:

- quality management
- production supervision
- product process design
- facility planning and management

Common job duties of ITec Occupational Safety graduates include:

- development, management, and evaluation of safety programs and systems
- hazard identification and mitigation
- loss prevention

The certificate in occupational safety is designed to meet the needs of the students who will find themselves in management roles with responsibilities that include safety. The certificate program prepares technically-oriented managers to meet their professional safety responsibilities.

For more information about the Industrial Technology degree: <http://www.abe.iastate.edu/undergraduate-students/industrial-technology/>

For more information about the occupational safety certificate: <http://www.abe.iastate.edu/home/certificate-in-occupational-safety/>

## Total Degree Requirement: 120 cr.

Only 65 cr. from a two-year institution may apply which may include up to 16 technical cr.; 9 P-NP cr. of free electives; 2.00 minimum GPA.

## Communications Proficiency:

6 cr. of English composition with a C or better and 3 cr. of speech fundamentals with a C or better.

## Communication/Library: 13 cr.

ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
LIB 160	Information Literacy	1
One of the following:		3
ENGL 302	Business Communication	
ENGL 309	Proposal and Report Writing	
ENGL 314	Technical Communication	
AGEDS 327	Survey of Agriculture and Life Sciences Communication	
One of the following:		3
SP CM 212	Fundamentals of Public Speaking	
COMST 214	Professional Communication	
AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	

**Total Credits 13**

## Mathematical, Physical, and Life Sciences: 25 cr.

STAT 104	Introduction to Statistics	3
MATH 145	Applied Trigonometry	3
MATH 151	Calculus for Business and Social Sciences	3
PHYS 111	General Physics	5
CHEM 163	College Chemistry	4
CHEM 163L	Laboratory in College Chemistry	1
One of the following:		3
BIOL 101	Introductory Biology	
BIOL 211	Principles of Biology I	
BIOL 212	Principles of Biology II	

Second Biology course requirement by Option: 3

## Manufacturing option

Life Sciences Elective from approved College of Agriculture and Life Sciences list

## Occupational Safety option

BIOL 255 Fundamentals of Human Anatomy

**Total Credits 25**

## Business, Humanities, Ethics, and Social Sciences: 18 cr.

ACCT 284	Financial Accounting	3
ECON 101	Principles of Microeconomics	3
TSM 370	Occupational Safety (Ethics)	3
Humanities course from College of Agriculture and Life Sciences list		3
International Perspectives course from University list		3

U.S. Diversity course from University list	3
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<b>Total Credits</b>	<b>18</b>
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**Technical Core: 30 cr.**

TSM 110	Introduction to Technology	1
TSM 111	Experiencing Technology	1
TSM 115	Solving Technology Problems	3
TSM 116	Introduction to Design in Technology	3
TSM 201	Preparing for Workplace Seminar	1
TSM 210	Fundamentals of Technology	3
TSM 214	Managing Technology Projects	1
TSM 270	Principles of Injury Prevention and Safety	3
TSM 310	Total Quality Improvement	3
TSM 363	Electrical Power Systems and Electronics for Agriculture and Industry	4
TSM 397	Internship in Technology	R
TSM 399	Work Experience in Technology	2
TSM 415	Applied Project Management in Technology	2
TSM 416	Technology Capstone	3
<b>Total Credits</b>		<b>30</b>

**No more than 4 cr. of TSM 399 may count toward graduation.  
Manufacturing Option: 34 cr.**

TSM 216	Advanced Technical Graphics, Interpretation, and CAD	2
A B E 271, A B E 272, or A B E 273		1
TSM 240	Introduction to Advanced Manufacturing and Metals Processing	3
TSM 241	Introduction to Manufacturing Processes for Plastics	2
TSM 337	Fluid Power Systems Technology	3
TSM 340	Advanced Automated Manufacturing Processes	3
TSM 440	Cellular Lean Manufacturing Systems	3
TSM 443	Statics and Strength of Materials for Technology	3
TSM 444	Facility Planning	3
TSM 465	Automation Systems	3
8 credits of free electives		8
<b>Total Credits</b>		<b>34</b>

**Occupational Safety Option: 34 cr.**

TSM 240	Introduction to Advanced Manufacturing and Metals Processing	3
TSM 371	Occupational Safety Management	2
TSM 372	Legal Aspects of Occupational Safety and Health	2
TSM 376	Fire Protection and Prevention	3

TSM 470	Industrial Hygiene: Physical, Chemical, and Biological Hazards	3
TSM 471	Safety Laboratory	1
TSM 477	Risk Analysis and Management	3
H S 105	First Aid and Emergency Care	2
PSYCH 250	Psychology of the Workplace	3
12 credits of free electives		12
<b>Total Credits</b>		<b>34</b>

## Industrial Technology, B.S. - manufacturing option

**First Year**

Fall	Credits	Spring	Credits
TSM 110	1	TSM 111	1
TSM 116	3	TSM 115	3
ENGL 150	3	MATH 151	3
LIB 160	1	PHYS 111	5
MATH 145	3	ECON 101	3
CHEM 163	4		
CHEM 163L	1		
	<b>16</b>		<b>15</b>

**Second Year**

Fall	Credits	Spring	Credits
TSM 201	1	TSM 216	2
TSM 210	3	TSM 241	2
TSM 214	1	STAT 104	3
TSM 240	3	BIOL 101 or 211	3
TSM 270	3	International Perspectives - See list*	3
ENGL 250	3	SP CM 212, COMST 214, or AGEDS 311	3
	<b>14</b>		<b>16</b>

**Third Year**

Fall	Credits	Spring	Credits	Summer	Credits
TSM 340	3	TSM 310	3	TSM 397	R
TSM 363	4	TSM 337	3		
ACCT 284	3	TSM 370 (Ethics requirement)	3		

US Diversity - See list*	3 A B E 271, 272, or 273	1
ENGL 302, 309, 314, or AGEDS 327	3 Humanities - See list*	3
	Life Science - See list*	3

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**16**                      **16**                      **0**

**Fourth Year**

Fall	Credits	Spring	Credits
TSM 399		2 TSM 416	3
TSM 415		2 TSM 444	3
TSM 440		3 TSM 465	3
TSM 443		3 Elective	4
Elective	4		

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- \* International Perspectives course list (<https://www.registrar.iastate.edu/students/div-ip-guide/IntlPerspectives-current/>)
- US Diversity course list (<https://www.registrar.iastate.edu/students/div-ip-guide/usdiversity-courses/>)
- Humanities course list (<https://www.cals.iastate.edu/student-services/humanities/>)
- Life Science course list (<https://www.cals.iastate.edu/student-services/life-science/>)

Industrial Technology, B.S. - occupational safety option

**First Year**

Fall	Credits	Spring	Credits
TSM 110		1 TSM 111	1
TSM 116		3 TSM 115	3
ENGL 150		3 MATH 151	3
LIB 160		1 PHYS 111	5
MATH 145		3 ECON 101	3
CHEM 163	4		
CHEM 163L	1		

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**Second Year**

Fall	Credits	Spring	Credits
TSM 201		1 TSM 240	3
TSM 214		1 TSM 371	2
TSM 210		3 H S 105	2

TSM 270	3 STAT 104	3
ENGL 250	3 BIOL 155	3
BIOL 101 or 211	3 SP CM 212, COMST 214, or AGEDS 311	3

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**14**                      **16**

**Third Year**

Fall	Credits	Spring	Credits	Summer	Credits
TSM 363		4 TSM 310		3 TSM 397	R
TSM 372		2 TSM 370		3	
TSM 376		3 TSM 471		1	
ENGL 302, 309, 314, or AGEDS 327		3 TSM 470		3	
Elective		3 ACCT 284		3	
		International Perspectives*		3	

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**Fourth Year**

Fall	Credits	Spring	Credits
TSM 399		2 TSM 416	3
TSM 415		2 US Diversity*	3
TSM 477		3 Humanities*	3
PSYCH 250		3 Elective	5
Elective	4		

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**14**                      **14**

- \* International Perspectives course list (<https://www.registrar.iastate.edu/students/div-ip-guide/IntlPerspectives-current/>)
- U.S. Diversity course list (<https://www.registrar.iastate.edu/students/div-ip-guide/usdiversity-courses/>)
- Humanities course list (<https://www.cals.iastate.edu/student-services/humanities/>)
- Life Science course list (<https://www.cals.iastate.edu/student-services/life-science/>)

## Minor - Industrial Technology

The Department of Agricultural and Biosystems Engineering offers a minor in industrial technology which may be earned by completing a minimum of 15 credits of technology systems management (TSM) courses, which includes:

TSM 115	Solving Technology Problems	3
TSM 210	Fundamentals of Technology	3
9 credits from:		9
TSM 216	Advanced Technical Graphics, Interpretation, and CAD	
TSM 240	Introduction to Advanced Manufacturing and Metals Processing	
TSM 241	Introduction to Manufacturing Processes for Plastics	
TSM 270	Principles of Injury Prevention and Safety	
TSM 310	Total Quality Improvement	
TSM 337	Fluid Power Systems Technology	
TSM 340	Advanced Automated Manufacturing Processes	
TSM 363	Electrical Power Systems and Electronics for Agriculture and Industry	
TSM 370	Occupational Safety	
TSM 371	Occupational Safety Management	
TSM 372	Legal Aspects of Occupational Safety and Health	
TSM 376	Fire Protection and Prevention	
TSM 440	Cellular Lean Manufacturing Systems	
TSM 443	Statics and Strength of Materials for Technology	
TSM 444	Facility Planning	
TSM 465	Automation Systems	
TSM 470	Industrial Hygiene: Physical, Chemical, and Biological Hazards	
TSM 471	Safety Laboratory	
TSM 477	Risk Analysis and Management	

• At least six (6) credits of 300-level or higher TSM classes (from the courses listed above)

• At least nine (9) credits that are not used to meet any other department, college, or university requirement.

**Total Credits** 15

For the undergraduate curriculum in agricultural systems technology leading to the degree of bachelor of science or for the undergraduate curriculum in industrial technology leading to the degree of bachelor of science.

The department also offers an undergraduate curricula and courses in agricultural engineering, biological systems engineering.

## Certificate in occupational safety

The Department of Agricultural and Biosystems Engineering offers a undergraduate certificate in occupational safety (<http://www.abe.iastate.edu/undergraduate-students/industrial-technology/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 and Safety	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

### Courses primarily for undergraduates:

#### TSM 110: Introduction to Technology

(1-0) Cr. 1. F.

*Prereq: AST or I Tec majors only or permission of instructor*

Team-oriented introduction to agricultural systems technology and industrial technology. Internships, careers, competencies, academic success strategies, transition to academic life.

#### TSM 111: Experiencing Technology

(0-2) Cr. 1. F.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. Internships, competencies, industry visits.

#### TSM 115: Solving Technology Problems

(2-2) Cr. 3. F.S.

*Prereq: Credit or enrollment for credit in MATH 140 or higher*

Solving technology problems using modern hardware and software tools for data-driven solutions. Problem solving cycle, unit conversion, unit factor method, SI and engineering units, significant figures, data collecting and cleaning, error analysis, data visualization, curve fitting, and computer coding fundamentals (data types, flow control, I/O handling, visualization, debugging). Strong emphasis on critical thinking, systematic problem solving, and effective communication.

#### TSM 116: Introduction to Design in Technology

(2-2) Cr. 3. F.S.

Use of parametric solid modeling software to create three dimensional solid models and document parts and assemblies. Includes national and international standards for documentation, design projects, and teamwork. Rapid prototyping design creation, 3D printing, assemblies, rendering, and detailing technical drawings.

**TSM 201: Preparing for Workplace Seminar**

(Cross-listed with A B E). (1-0) Cr. 1. F.S.

*Prereq: Prereq: Sophomore classification in AE, AST, BSE, or I TEC*  
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; Cover Letters; Behavioral Based Interviewing; Industry Speakers; Preparation for internships experiences.

**TSM 210: Fundamentals of Technology**

(3-0) Cr. 3. F.S.

*Prereq: TSM 115 or equivalent; and MATH 140 or higher*  
Introduction to problem solving related to fundamental agricultural and/or industrial technology systems and mathematical tools needed for data analysis. Basic laws of energy, force, and mass applied to technology systems such as: mechanical power transmission; heating, ventilation and air conditioning; electrical circuits. Introduction to engineering economics: using the time value of money to make economic decisions.

**TSM 214: Managing Technology Projects**

(2-0) Cr. 1. F.S.

*Prereq: TSM 201 or A B E 201; and sophomore classification in A E, AST, BSE, or ITEC.*

8 week course. Introduction to project management principles. Use of project management in technology-based projects for academic, industry, and personal use.

**TSM 216: Advanced Technical Graphics, Interpretation, and CAD**

(1-2) Cr. 2. F.S.

*Prereq: TSM 116*  
Advanced computer-aided-design topics incorporating 3D design and documentation used in manufacturing settings. Topics include: geometric dimensioning and tolerancing, weldments, sheet metal parts, advanced visualization, feature based design of parts and assemblies.

**TSM 240: Introduction to Advanced Manufacturing and Metals Processing**

(1-4) Cr. 3. F.S.

*Prereq: MATH 145*  
A study of selected materials, properties, and related processes used in metals manufacturing. Lecture and laboratory activities focus on processes and advanced manufacturing.

**TSM 241: Introduction to Manufacturing Processes for Plastics**

(Cross-listed with FS HN). (1-2) Cr. 2. F.S.

*Prereq: MATH 145*  
A study of selected materials and related processes used in plastics manufacturing. Lecture and laboratory activities focus on materials, properties, and processes.

**TSM 270: Principles of Injury Prevention and Safety**

(3-0) Cr. 3. F.S.

Basic foundations of injury causation and prevention from a personal perspective in home, motor vehicle, and the public environment, and a management perspective within the work environment. Offered online only.

**TSM 310: Total Quality Improvement**

(3-0) Cr. 3. F.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 - emphasis on team work and problem solving skills.

**TSM 322: Preservation of Grain Quality**

(3-0) Cr. 3. 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. Insect pest control. Grain quality monitoring.

**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. Insect pest control. Grain quality monitoring. Industry tour.

**TSM 324: Soil and Water Conservation Management**

(2-2) Cr. 3. S.

*Prereq: MATH 140 or MATH 151*  
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 B E). (3-0) Cr. 3. F.

*Prereq: 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**

(2-2) 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: MATH 145 or MATH 151; and TSM 210*

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 335: Tractor Power**

(3-3) Cr. 4. F.

*Prereq: TSM 210, MATH 145*

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. F.S.

*Prereq: TSM 210*

Fundamental fluid power principles, symbols and schematics. Fluid properties. Function and performance of components such as connections and fittings, filtration, pumps, valves, actuators, hydrostatic transmission. Analysis of fluid power circuits and systems. Introduction to electrohydraulics. Fluid power trainers.

**TSM 340: Advanced Automated Manufacturing Processes**

(2-2) Cr. 3. F.S.

*Prereq: TSM 210, TSM 216, TSM 240, MATH 151*

NC programming operations and machining practices for CNC mills and lathes. Transfer of part descriptions into detailed process plans, tool selection, and NC codes. Use of CAD/CAM for automated NC programming in 2D/3D machining operations of student designed parts.

**TSM 363: Electrical Power Systems and Electronics for Agriculture and Industry**

(3-3) Cr. 4. F.S.

*Prereq: TSM 210, MATH 145*

Fundamental electrical theory and application, code requirements, and safety considerations. Single-phase, split-phase, and three-phase circuit design, analysis, and safety considerations; electric motor performance and selection; reactive power and correction; safety devices and circuits; transformer selection and configuration; industrial and motor controls; conductor characteristics, selection and safety; system troubleshooting; and schematic development and analysis. Emphasis on agricultural and industrial applications.

**TSM 370: Occupational Safety**

(3-0) Cr. 3. F.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.

**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. F.

*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. F.

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. Repeatable. F.S.SS.

*Prereq: At least 45 credits of coursework, 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 in 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: Applied Project Management in Technology**

(1-2) Cr. 2. F.S.

*Prereq: Senior classification with less than 32 credits remaining; TSM 214; and credit or enrollment for credit in TSM 310.*

Implementation of project management principles using case studies and teamwork; problem definition in a technology context; development of charter for technology capstone project.

**TSM 416: Technology Capstone**

(1-4) Cr. 3. F.S.

*Prereq: TSM 415 in previous semester*

Application of project management tools to a technology capstone project; development and evaluation of potential solutions using tools from the technology curriculum; problem resolution emphasizing communication, critical analysis, and planning techniques; presentation of project through oral presentation and written reports with input from client, faculty, and other stakeholders.

**TSM 433: Precision Agriculture**

(Dual-listed with TSM 533). (2-2) Cr. 3. F.

*Prereq: Junior standing.*

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.

**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, and A3. 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; and MATH 145 or MATH 151*

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.S.

*Prereq: TSM 216; TSM 240; and STAT 101 or STAT 104*

Fundamental principles and practices in designing, evaluating, and organizing new or existing facilities. Emphasis on AutoCAD-based facility design and production flow analysis, activity relationship analysis, lighting analysis, time studies, materials handling, supporting services design, and optimal facility location analysis.

**TSM 455: Feed Processing and Technology**

(Dual-listed with TSM 555). Cr. 3. F.

*Prereq: Junior classification*

Introduction to formula feed manufacturing and the animal feed industry. Overview of feed ingredients and formulation, understanding and operation of feed production processing equipment including principles of conveying, grinding, mixing, conditioning, pelleting, and other processing techniques, and the formulation of concentrates, premixes, and rations. Students will become knowledgeable about the manufacturing of various animal feed types such as pelleted and extruded feed, aqua (fish) feed, liquid feeds, poured and pressed blocks, steam flaked feed, and pet food, and their effect on animal performance and health.

**TSM 457: Feed Safety, Ingredient Quality and Analytics**

(Dual-listed with TSM 557). Cr. 3. S.

*Prereq: Junior classification*

Concepts of feed and grain safety and quality, including hazards and risks associated with common feeds and feed ingredients. Methods to monitor, manage, and mitigate hazards and risks in the context of feed and grain industries. Government regulations applicable to feed and grain safety. Differences between safety and quality factors, how they are measured and then used for decision-making (marketing, processing, or safe-use).

**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**

(Dual-listed with TSM 570). (3-0) Cr. 3. S.

*Prereq: MATH 151 or higher*

A qualitative and quantitative introduction to health effects of chemical, biological, and physical hazards in a workplace.

**TSM 471: Safety Laboratory**

(0-2) Cr. 1. S.

*Prereq: Credit or enrollment for credit in TSM 470*

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. F.

*Prereq: MATH 151; and 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 4900: 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 495: Agricultural and Biosystems Engineering Department Study Abroad Preparation or Follow-up**

(Cross-listed with A B E). Cr. 1-2. Repeatable. F.S.SS.

*Prereq: Permission of instructor*

Preparation for, or follow-up of, study abroad experience (496). For preparation, course focuses on understanding the tour destination through readings, discussions, and research on topics such as the regional industries, climate, crops, culture, economics, food, geography, government, history, natural resources, and public policies. For follow-up, course focuses on presentations by students, report writing, and reflection. Students enrolled in this course intend to register for 496 the following term or have had taken 496 the previous term.

Meets International Perspectives Requirement.

**TSM 496: Agricultural and Biosystems Engineering Department Study Abroad**

(Cross-listed with A B E). Cr. 1-4. Repeatable. F.S.SS.

*Prereq: Permission of instructor*

Tour and study at international sites relevant to disciplines of industrial technology, biological systems engineering, agricultural systems technology, and agricultural engineering. Location and duration of tours will vary. Trip expenses paid by students. Pre-trip preparation and/or post-trip reflection and reports arranged through 495.

Meets International Perspectives Requirement.

**Courses primarily for graduate students, open to qualified undergraduates:****TSM 533: Precision Agriculture**

(Dual-listed with TSM 433). (2-2) Cr. 3. F.

*Prereq: Junior standing.*

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.

**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 stream 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 555: Feed Processing and Technology**

(Dual-listed with TSM 455). Cr. 3. F.

*Prereq: Junior classification*

Introduction to formula feed manufacturing and the animal feed industry. Overview of feed ingredients and formulation, understanding and operation of feed production processing equipment including principles of conveying, grinding, mixing, conditioning, pelleting, and other processing techniques, and the formulation of concentrates, premixes, and rations. Students will become knowledgeable about the manufacturing of various animal feed types such as pelleted and extruded feed, aqua (fish) feed, liquid feeds, poured and pressed blocks, steam flaked feed, and pet food, and their effect on animal performance and health.

**TSM 557: Feed Safety, Ingredient Quality and Analytics**

(Dual-listed with TSM 457). Cr. 3. S.

*Prereq: Junior classification*

Concepts of feed and grain safety and quality, including hazards and risks associated with common feeds and feed ingredients. Methods to monitor, manage, and mitigate hazards and risks in the context of feed and grain industries. Government regulations applicable to feed and grain safety. Differences between safety and quality factors, how they are measured and then used for decision-making (marketing, processing, or safe-use).

**TSM 570: Industrial Hygiene: Physical, Chemical, and Biological Hazards**

(Dual-listed with TSM 470). (3-0) Cr. 3. S.

*Prereq: MATH 151 or higher*

A qualitative and quantitative introduction to health effects of chemical, biological, and physical hazards in a workplace.

**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. F.

*Prereq: MATH 151; and 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 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 advisor. Three credits required for all nonthesis master's degree students.

**Courses for graduate students:****TSM 601: Graduate Seminar**

(Cross-listed with A B E). (1-0) Cr. 1. F.

Keys to starting a successful graduate research project. Effective literature review, formulating research questions, and setting goals. Practicing effectively communicating research and science. Effective strategies for scholarly writing, professional development, responding to feedback, peer-reviewing, successful publishing in journals, and curating scholarly output.

**TSM 652: Program and Learner Evaluation**

(3-0) Cr. 3.

*Prereq: STAT 587 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 course development using the backward design process.

**TSM 694: Teaching Practicum**

(Cross-listed with A B E). Cr. 1-3. F.S.

*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 699: Research**

Cr. arr.