Manufacturing Systems Engineering and Management

College of Engineering and Computer Science

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Programs

Undergraduate:

- B.S. Enginerring Management
- B.S., Manufacturing Systems Engineering
- B.S., Engineering Management**
- Minor in Manufacturing Systems Engineering

Graduate:

- M.S., Engineering Management *
- M.S., Manufacturing Systems Engineering
- M.S., Materials Engineering

*Modes of instruction for this program are residential on-campus or online distance learning through the Tseng College of Extended Learning.

**Pending approval of the Chancellor's Office.

Mission Statement

To successfully guide our students in their acquisition and development of the specialized knowledge and skills essential to the professional practice of engineering management for the betterment of society.

The Major

More than two-thirds of all engineering professionals invest a significant portion of their career in managing and administering a wide range of technical engineering and research projects and budgets. As the engineering profession evolves, an increasing need has emerged for entry-level engineering professionals who have both a broad engineering background and the knowledge and ability to interface between the business and technical functions of organizations. Undergraduate engineering management majors learn engineering fundamentals, together with the art and science of planning, organizing, allocating resources, and directing and controlling activities in technological environments. The Bachelor of Science in Engineering Management equips entry-level engineers with knowledge of the business of engineering, making them valuable to their employers and ensuring future professional growth. For students who enjoy people and technology, the technical challenges of engineering, and the opportunity to integrate higher-level organizational considerations into technological decision-making processes, engineering management is an ideal program of study.

The undergraduate engineering management degree program includes studies in basic mathematics and sciences, the engineering sciences, engineering management disciplinary studies, and technical electives, as well as general education. The selection of technical electives can be tailored to particular areas of student interest. The team project experiences in many courses approximate the professional environment that graduates will encounter in their future careers. Program culminating experiences include community service learning course projects and capstone course design projects. Students have access to the well-equipped laboratories, including computing laboratories with discipline-specific software, that are essential to achievement of program objectives.

Students have opportunities to participate in the technical and social activities sponsored by the student chapters of many professional organizations. Program majors are also eligible to apply for internships in the Honors Co-op Program hosted by the college, as well as a variety of scholarships and awards.

Academic Advisement

Please contact the Graduate Coordinator, Behzad Bavarian, at (818) 677-2167 for information about graduate programs.

Educational Objectives of the Undergraduate Program in Engineering Management

Practicing professionals holding the Bachelor of Science in Engineering Management will exemplify:

1. The technical and managerial abilities to apply knowledge of engineering to the design, analysis, and integration of effective engineering management systems in contemporary technological environments;
2. The intellectual breadth and lifelong intellectual curiosity required to practice engineering management creatively, sensitively, and responsibly in contemporary global and societal environments;
3. The ability to communicate effectively and to function productively on multicultural and multidisciplinary teams; and
4. The desire and ability to preserve the nobility of the engineering profession in its dedication to the welfare of society by nurturing ethical and professional responsibilities.

Student Learning Outcomes of the Undergraduate Program in Engineering Management

Students in the Bachelor of Science in Engineering Management will attain:

1. the ability to apply knowledge of mathematics, science and engineering to engineering management;
2. the ability to design and conduct experiments, as well as to analyze and interpret data;
3. the ability to design and manage effective systems, processes, and environments for contemporary technological organizations;
4. the ability to function productively on multicultural and multidisciplinary teams;
5. the ability to identify, formulate, and solve engineering problems;
6. the ability to understand, practice and nurture professional and ethical responsibilities;
7. the ability to communicate effectively in both the written and spoken modes;
8. the intellectual and educational breadth necessary for understanding the impact of engineering management solutions in a global and societal context;
9. a recognition of the need for professional currency, and an ability to engage in perpetual learning;
10. a knowledge of contemporary issues in society, as well as those of the profession;
11. the ability to select and use contemporary methods, techniques, skills and tools for effective engineering management practice;
12. the ability to discern and assess the relationships between engineering management functions and the human element in technological organizations;

13. the ability to treat the uncertainties inherent in engineering management systems; and
14. the ability to integrate engineering management systems in technological environments.

Careers

Students completing the Bachelor of Science in Engineering Management will find career opportunities in almost any area of industry or government operating in a technological environment where interfaces between business and technical functions are required, such as aerospace, health services, transportation services, entertainment, manufacturing, financial services, consulting, education, public utilities, and government services. The breadth and flexibility of the program also provides graduates with entry-level opportunities in new and small businesses.

Graduates from undergraduate engineering management programs have applied their knowledge and skills to a wide range of position functions, including production scheduling, quality engineering, facilities engineering, operations supervision, cost estimating, value analysis, manufacturing planning, project engineering, operations management, technology procurement, plant layout, logistics, economic and financial analysis, and technical marketing. The degree can also serve as a stepping-stone to graduate work in several fields.

Requirements for the Bachelor of Science In Engineering Management

This program is based on an expectation of adequate high school preparation in science, mathematics, and English. Science courses should include chemistry or physics, both of which are desirable. High school mathematics courses should include algebra, plane geometry, and trigonometry. Four years of English are required. Beginning students must take (or be exempt from) the Entry Level Mathematics Test, and the Mathematics, Chemistry, and English Placement Tests, before registration in basic courses is permitted.

Students who have not had an adequate background of pre-engineering work in high school may be required to complete some additional work in their first year and may not be able to complete the program in eight semesters. Students are referred to the section of the University catalog entitled Appendices-Admission regarding rules and regulations as to earned college credit.

1. Lower Division Required Courses (44 Units)

Freshman Year

CHEM	101/L	General Chemistry and Lab(4/1)
MATH	150A	Calculus I (5)
MATH	150B	Calculus II (5)
PHYS	220A/L	Mechanics and Lab (3/1)
MSE	101/L	Introduction to Engineering and Lab (1/1)

Sophomore Year

MATH	250	Calculus III (3)
MATH	280	Applied Differential Equations (3)
PHYS	220B/L	Electricity and Magnetism and Lab (3/1)
MSE	227/L	Engineering Materials and Lab (3/1)
MSE	248/L	Engineering CAD Graphics and Lab (2/1)

With faculty advisor approval, select two courses from:

CE	240	Engineering Statics(3)
ECE	240	EE Fundamentals (3)
ME	286A/L	ME Design I and Lab (2/1)

2. Upper-divison Required Courses (37 Units)

Junior Year

MSE	304	Engineering Economic Analysis (3)
MSE	362	Engineering Statistical Applications (3)
MSE	401	Introduction to Engineering and Technology Management (3)
MSE	402	Engineering Project Management (3)
MSE	406	Engineering Cost Analysis (3)
MSE	407	Production Systems (3)

Senior Year

MSE	403CS	Facilities Planning and Design (3)
MSE	410/L	Production Systems Modeling and Lab (2/1)
MSE	415	Product Design (3)
MSE	488A	MSEM Senior Design I (2)
MSE	488BCS	MSEM Senior Design II (2)

With faculty advisor approval, select two courses from:

AM	316	Engineering Dynamics (3)
CE	340	Strength of Materials (3)
ECE	320	Theory of Digital Systems (3)
ME	370	Thermodynamics (3)
ME	375	Heat Transfer (3)

3. Upper Division Major Elective Courses (12 Units)

With faculty advisor approval, select four courses from among department 400-level and /or 500-level courses

General Education: Engineering Management majors have modified General Education programs depending upon the year and enrollment status as a college student. Returning and transfer students should consult an advisor before planning their General Education programs.

In addition to the required major program courses, Engineering Management majors must satisfactorily complete General Education Plan R requirements in Analytical Reading and Expository Writing (3 units), Oral Communication (3 units), U.S. History and Local Government (6 units), Arts and Humanities (6 units), Social Sciences (3 units), and Comparative Cultural Studies (6 units). Six of the General Education Plan R units must be at the Upper Division.

Students should carefully consult their four-year plan and confer with their faculty advisor when selecting their General Education Plan R courses.

Total Units in the Major	93
General Education Units*	27
Additional Units	27
Total Units Required for the. Degree	120

Bachelor of Science In Manufacturing Systems Engineering:

Mission Statement

To successfully guide our students in their achievement of the educational objectives articulated for all undergraduate engineering programs at California State University, Northridge, and acquisition and development of the specialized knowledge and skills essential to their professional competence in the design, implementation, and management of contemporary manufacturing and production methods and systems.

The Major

Manufacturing Systems Engineers turn ideas into reality. They play key roles in the creation of almost every single product that you see or use, from clothing to computers, from automobiles to space shuttles, from frozen foods to toys. The challenges of creating and using new materials to meet future needs, relieving human drudgery by automating dangerous and onerous production processes, forming and leading teams of engineering experts; all are examples of a few of the numerous opportunities for which the Manufacturing Systems Engineering program prepares its students.

Manufacturing Systems Engineering majors at Cal State Northridge receive a solid, broad-based education. The program is designed to ensure student intellectual growth in four primary proficiency areas:
(1) the design and manufacture of products, **(2)** the design of manufacturing systems, **(3)** materials and manufacturing processes, and **(4)** the management of production processes and resources.

Individual and team assignments on projects and in laboratories provide students with numerous opportunities to develop their technical, design, leadership, communication, management, and team skills. Students in the Manufacturing Systems Engineering program have the opportunity to work on projects in nine laboratories:
(1) Advanced Corrosion Lab, **(2)** Advanced Materials Lab,
(3) Boeing Automation Engineering Lab, **(4)** CAE Design Lab.
(5) Fracture Mechanics Lab, **(6)** MacDonald CAD Graphics Lab. **(7)** Manufacturing Processes Lab, **(8)** MSEM Design Projects Lab. **(9)** Pickett Engineering Materials Lab.

In senior design, Manufacturing Systems Engineering students also use the real world as their basic lab, by executing real projects in local industry. Projects have included design and production of competition robots, design and development of a CD-ROM counter, design of an improved packaging process for industrial adhesives and polymers, planning and design of a facility for electronics manufacturing, plant layout design for the production of a medical patient monitor, and development of an ISO-9000 quality assurance system.

Small classes are taught by a group of dedicated faculty who among them hold several outstanding teaching and faculty awards, are nationally and internationally recognized for their technical publications and work in engineering professional organizations, and have engineering and management experience in industry to share with their students.

Manufacturing Systems Engineering students have opportunities to participate in student chapters of professional societies such as SAMPE (Society for the Advancement of Material and Process Engineering) and SME (Society of Manufacturing Engineers), as well as interdisciplinary student organizations in the College, such as Tau Beta Pi, the Society of Women Engineers, the National Society for Black Engineers, and the Society for Hispanic Professional Engineers.

The Manufacturing Systems Engineering program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: (410) 347-7700.

Educational Objectives

The educational objectives of the Bachelor of Science in Manufacturing Systems Engineering are to ensure that each graduate exemplifies:

1. The technical and managerial abilities to apply knowledge of manufacturing systems engineering to the development and implementation of effective processes, systems and environments for contemporary manufacturing enterprises;
2. The intellectual breadth of a liberal arts education and an ensuing ability to practice manufacturing systems engineering creatively, sensitively, and responsibly in the global environment;
3. The habit of intellectual curiosity and a desire for perpetual learning, together with their application to the maintenance of professional currency in manufacturing systems engineering;
4. The ability to communicate competently in both the written and spoken modes, and to function productively on multicultural and multidisciplinary teams; and
5. The desire and ability to preserve the nobility of the engineering profession in its dedication to the welfare of society by nurturing ethical and professional responsibilities.

Student Learning Outcomes of the Undergraduate Program

Graduates of the Bachelor of Science in Manufacturing Systems Engineering at California State University, Northridge will have:

a. an ability to apply knowledge of mathematics, science and engineering;
b. an ability to design and conduct experiments, as well as to analyze and interpret data;
c. an ability to design and manage effective systems, processes, and environments for contemporary manufacturing enterprises;
d. an ability to function productively on multicultural and multidisciplinary teams;
e. an ability to identify, formulate, and solve manufacturing systems engineering problems;
f. an ability to understand, practice, and nurture professional and ethical responsibilities;
g. an ability to communicate effectively in both the written and spoken modes;
h. the intellectual and educational breadth necessary for understanding the impact of manufacturing systems engineering solutions in a global and societal context;
i. a recognition of the need for professional currency, and an ability to engage in perpetual learning;
j. a knowledge of contemporary issues in society, as well as those of the profession;
k. an ability to use the contemporary techniques, skills, and tools necessary for effective manufacturing systems engineering practice;
l. an understanding of the behavior and properties of materials as they are altered and influenced by processing in manufacturing;
m. an understanding of the design of products, and the equipment, tooling and environment necessary for their manufacture;
n. an understanding of the creation of competitive advantage through effective management of contemporary manufacturing enterprises;
o. an ability to apply advanced methods to the analysis, synthesis, and control of manufacturing systems; and
p. an ability to measure manufacturing process variables and draw credible technical inferences.

Careers

Manufacturing Systems Engineering is a growing discipline area in the engineering profession. Four of the seven technology areas that have been identified for rapid development by the National Science Foundation —Advanced Manufacturing Technologies, Advanced Materials and Processing, Biotechnology, and Health Care Delivery Systems—are particularly well-suited for the talents of the Manufacturing Systems Engineer. Employment opportunities abound in the metropolitan Los Angeles area, the leading manufacturing region in the United States.

On the job, Manufacturing Systems Engineers develop new facilities, create computer models and images of products and processes, manage the production process, conduct productivity studies, test products and evaluate materials, trouble-shoot on the factory floor, and work hand-in-hand with design engineers. Because their background is broad and the types of work are so varied, these engineers find opportunities in fields besides manufacturing, applying their skills and knowledge in such diverse environments as hospitals, entertainment firms, and consulting firms. Many Manufacturing Systems Engineers are noted for starting their own companies or pursuing Engineering Management career paths in large companies.

Although most Manufacturing Systems Engineers are employed in private industry, others pursue careers with government agencies or educational institutions. The degree can be used as a stepping-stone to graduate work in engineering, law, business, or even medicine. Many B.S. Manufacturing Systems Engineering graduates return to Cal State Northridge to earn their M.S. degree in the Engineering Management, Manufacturing Systems Engineering, or Materials Engineering programs.

Requirements for the Bachelor of Science In Manufacturing Systems Engineering:

High School Preparation: This program is based upon an expectation of adequate high school preparation in science, mathematics, and English. High school courses should include algebra, plane geometry, trigonometry and chemistry or physics (both desirable), and four years of English. Beginning engineering students must take the Entry Level Mathematics Test and the Mathematics, Chemistry, and English Placement Tests before registration in basic courses will be permitted.

Students should refer to the Appendices section of this Catalog for Admission rules and regulations. Students who have not had an adequate background of pre-engineering work in high school may be required to take some additional work in their first year and may not be able to complete an engineering program in 8 semesters.

1. Lower Division Required Courses (45 Units)

Freshman Year

CHEM	101/L	General Chemistry I and Lab	4/1
MATH	150A	Calculus I (5)	
MATH	150B	Calculus II (5)	
PHYS	220A/L	Mechanics and Lab (3/1)	
MSE	101/L	Introduction to Engineering and Lab (1/1)	

Sophomore Year

MATH	250	Calculus III (3)
MATH	280	Applied Differential Equations (3)
PHYS	220B/L	Electricity and Magnetism and Lab (3/1)
CE	240	Engineering Statics (3)
ECE	240/L	Electrical Engineering Fundamentals and Lab (3/1)
MSE	227/L	Engineering Materials and Lab (3/1)
MSE	248/L	Engineering CAD and Graphics and Lab (2/1)

2. Upper Division Required Courses (37 Units)

Junior Year

AM	316	Engineering Dynamics (3)
or ME	370	Thermodynamics (3)
CE	340	Strength of Materials (3)
MSE	304	Engineering Economy (3)
MSE	362	Engineering Statistical Applications (3)
MSE	402	Engineering Project Management (3)
MSE	407	Manufacturing Systems (3)
MSE	409/L	Fundamentals of CAM and Lab (2/1)
MSE	412/L	Manufacturing Processes and Lab (2/1)

Senior Year

MSE	403CS	Facilities Planning and Design (3)
MSE	410/L	Manufacturing Systems Modeling/Lab (2/1)
MSE	415	Product Design (3)
MSE	488A/L	Manufacturing Systems Engineering Senior Design I (1/1)
MSE	488BCS	Manufacturing Systems Engineering Senior Design II (2)

3. Upper Division Major Elective Courses (12 Units)

Select four courses from among department 400-level and/or 500-level courses.

General Education: Manufacturing Systems Engineering majors have modified General Education programs depending upon the year and enrollment status as a college student. Returning and transfer students should consult an advisor before planning their General Education programs.

In addition to the required major program courses, Manufacturing Systems Engineering majors must satisfactorily complete General Education Plan R requirements in Analytical Reading and Expository Writing (3 units), Oral Communication (3 units), U.S. History and Local Government (6 units), Arts and Humanities (6 units), Social Sciences (3 units), and Comparative Cultural Studies (6 units). Nine of the General Education Plan R units must be at the Upper Division, Two courses units must meet the Information Competence requirement.

Students should carefully consult their four-year plan and confer with their faculty advisor when selecting their General Education Plan R courses.

Total Units in the Major	94
General Education Units*	27
Total Units Required for the Degree	121

Minor In Manufacturing Systems Engineering

Almost half of all engineering positions are in or related to Manufacturing. This minor is designed to augment undergraduate studies in engineering and closely related fields to facilitate student opportunities for achievement in a manufacturing environment. Some students may find it necessary to complete selected prerequisite courses in mathematics, chemistry, physics, and/or engineering.

Student Learning Outcomes

Students who complete the Minor in Manufacturing Systems Engineering at California State University, Northridge will demonstrate:

1. an understanding of the behavior and properties of materials as they are altered and influenced by processing in manufacturing;
2. an understanding of the design of products, and the equipment, tooling and environment necessary for their manufacture;
3. an understanding of the creation of competitive advantage through effective management of contemporary manufacturing enterprises;
4. an ability to apply advanced methods to the analysis, synthesis, and control of manufacturing systems; and
5. an ability to measure manufacturing process variables and draw credible technical inferences.

These student learning outcomes for the minor are consistent with proficiency area criteria assessed in accord with ABET (Accreditation Board for Engineering and Technology) requirements for Manufacturing and Similarly-Named Engineering Programs.

1. Required Courses (12 Units)

MSE	362	Engineering Statistical Applications (3)
MSE	407	Manufacturing Systems (3)
MSE	409/L	Fundamentals of Computer-Aided Manufacturing and Lab (2/1)
MSE	412/L	Manufacturing Processes and Lab (2/1)

2. Elective Courses (6 Units)

Each student must complete two courses selected from the list provided below. In some circumstances, other elective selections may be

suitable when approved **in advance** by the department.

MSE	402	Engineering Project Management (3)
MSE	403CS	Facilities Planning and Design (3)
MSE	410/L	Manufacturing Systems Modeling and Lab (2/1)
MSE	415	Product Design (3)

Total Units Required for the Minor 18

Requirements for the Master of Science in Engineering Management

Taught by faculty with professional engineering management experience, the Engineering Management program offers engineers and other technical professionals the opportunity to develop technical management and entrepreneurial skills pertinent to the management of existing and emerging technologies. The program stresses the development of technological decision-making abilities, while also enabling continued intellectual growth in an area that meets professional needs. Engineering Management program graduates have been assuming leadership roles in industry since the early 1970s.

Program Goals

The goals of the Master of Science in Engineering Management program are to provide opportunities for:

- the development of technical management decision-making abilities;
- the acquisition of knowledge about the management of existing and emerging technologies;
- the development of technical professional employee management skills;
- the acquisition of knowledge of engineering cost, financial, and economical analysis, and
- continued intellectual growth in a discipline-related area.

A. Requirements for Admission to the Program:

1. Satisfaction of all requirements for graduate admission to the University.
2. Approval by the Department Graduate Coordinator.

B. Requirements for Advancement to Classified Status:

1. Satisfaction of University requirements for classified status.
2. Approval of program of study plan by assigned faculty advisor.
3. Approval by the Department Graduate Coordinator.

C. Special Requirements:

1. This program is intended primarily for students holding a B.S. in Engineering or other technical field. Prospective students who work in technical environments and hold degrees in non-technical fields should contact the Department in order to discuss additional prerequisite courses with a faculty advisor.
2. Students entering the program are expected to have completed Engineering Management (MSE 504) or equivalent. Admitted students who have not completed such a course as part of an undergraduate program may complete the course as part of their graduate degree program of study.

Required Courses

1. Required Core Courses (18 units):

MSE	601A	Engineering Statistics I (3)
MSE	602	Advanced Engineering Management (3)
MSE	604	Economic Analysis of Engineering Systems (3)
MSE	606A	Engineering Operations Research I (3)
MSE	608B	Management of Engineering Professionals (3)
MSE	608C	Engineering Financial and Cost Analysis (3)

2. Culminating Experience (3 units):

MSE	697MGT	Engineering Management Directed Comprehensive Studies (3)

3. Culminating Experience (3 units, optional for qualified students):

MSE	692	Engineering Management Research Practicum (3)

4. Electives (12 units):

Elective courses are selected in consultation with a faculty advisor. At least 6 of the 12 units must be selected from approved courses in the department. No more than 6 of the 12 units may be at the 400-level. Frequently selected electives in Engineering Management include MSE 402, 407, 504, 505, 507, 601B, 606B, 617 and 618. Discipline electives in Automation and CAD/CAM, Computer Science, Electrical Engineering, Manufacturing Systems, Materials Engineering, Mechanical Engineering and Structural Engineering are also appropriate.

Distance Education Mode

The Master of Science in Engineering Management program is also offered in an asynchronous online mode, with all courses delivered via the internet. This online program is administered jointly with the Roland Tseng College of Extended Learning, and charges tuition that reflects the full cost of instruction.

Requirements for the Master of Science in Materials Engineering

To meet the technological needs of industry, the Master of Science in Materials Engineering program creatively combines opportunities for intellectual and experiential growth in engineering materials and processes. Access to exceptional state-of-the-art laboratories enables the development of advanced expertise in materials characterization, with projects addressing nanotechnology, MEMS, sensors, smart materials, microelectronics, optoelectronics, biomaterials, and environmentally-assisted cracking of advanced materials.

Program Goals

The goals of the Master of Science in Materials Engineering program are to:

1. enhance student knowledge of fundamental materials engineering principles;
2. expand student knowledge of nontraditional materials such as composites and electronic materials;
3. increase student knowledge of materials failure mechanisms;
4. develop student expertise in laboratory research methods in materials engineering;
5. enable student intellectual growth in discipline-related areas; and
6. meet the needs of the regional industrial community for qualified materials engineering expertise.

A. Requirements for Admission to the Program:

1. Satisfaction of all requirements for graduate admission to the University.
2. Approval by the Department Graduate Coordinator.

B. Requirements for Advancement to Classified Status:

1. Satisfaction of University requirements for classified status.
2. Approval of program of study plan by assigned faculty advisor.
3. Approval by the Department Graduate Coordinator.

C. Special Requirements:

1. This program is intended primarily for students holding a B.S. degree in a closely related field of science or engineering. Prospective students whose undergraduate degree is not in a closely related field should discuss additional prerequisite courses with the Program Director.

2. No more than 6 units of advisor-approved 400-level courses may be included in any graduate program of study.

Required Courses

1. Required Core Courses (12 units):

MSE	527/L	Mechanical Behavior of Materials (2/1)
MSE	528/L	Principles of Materials Engineering (2/1)
MSE	624	Failure Analysis (3)
MSE	629	Phase Transformations (3)

2. Culminating Requirements (6 units):

MSE	690	Materials Engineering Research Practicum (3)
MSE	697MTL	Materials Engineering Directed Comprehensive Studies (3)

3. Advisor-Approved Electives (15 units):

Recommended electives, selected with faculty advisor guidance and approval, include MEMS Fabrication (MSE 512), NDE Methods and Analyses (MSE 513), Corrosion (MSE 531), Biomaterials (MSE 536), Thin Film Technology (MSE 550), Nanomaterials (MSE 536) and Nanotechnology (MSE 556), Composite Materials (MSE 623), and Electronic Materials (MSE 630). Other electives may be suitable for meeting individual student program goals.

Requirements for the Master of Science In Manufacturing Systems Engineering

The Master of Science in Manufacturing Systems Engineering facilitates in-depth knowledge of manufacturing systems based on engineering principles. The core foundation in computer-based and automated design, manufacturing and assembly is complimented by expertise in selected areas, such as automation and CAD/CAM, materials and processes, and quality and management. The evolving curriculum, contemporary laboratory facilities, and internationally published faculty enable students and practicing professionals to pursue a versatile field of study having a wide range of career opportunities. The program places its graduates in the academic community and in every facet of industry.

Program Goals

The goals of the Master of Science in Manufacturing Systems Engineering are to:

1. expand student knowledge of manufacturing systems engineering principles;
2. ensure student understanding of breadth and depth of manufacturing environments;
3. enable student expertise in at least one of the following:
4. apabilities in automation and CAD/CAM manufacturing systems;

or 5. understanding the behavior and properties of materials and processes; *or*

6. competencies in quality and management engineering; and
7. develop student knowledge and abilities needed in the industrial community.

A. Requirements for Admission to the Program:

1. Satisfaction of all requirements for graduate admission to the University.
2. Approval by the Department Graduate Coordinator.

B. Requirements for Advancement to Classified Graduate Status

1. Satisfaction of University requirements for classified status.
2. Approval of program of study by assigned advisor.
3. Approval by the Department Graduate Coordinator.

C. Special Requirements

This program is intended primarily for students holding a B.S. degree in Engineering, Computer Science, or a related field. Prospective students who work in technical environments and hold degrees non-technical fields should contact the Department in order to discuss any prerequisite courses with a faculty advisor.

Required Courses (33 Units)

1. Required Core Courses (12 units)

MSE	508/L	CAD/CAM/ Systems and Lab (2/1)
MSE	511/L	Robotics with Applications and Lab (2/1)
MSE	603	Computer Integrated Manufacturing (3)
MSE	614	Intelligent Manufacturing (3)

2. Required Specialization Courses (6 units)

Each student must choose one of the three areas of specialization as given below:

Automation and CAD/CAM

MSE	509	CAM Systems (3)
MSE	516/L	CAD/CAM Advanced Tools and Lab (2/1)
MSE	611	Robotics and Programmable Automation (3)
MSE	609	Advanced Topics in CAD/CAM (3)

Materials and Processes

MSE	512	Fundamentals of MEMS Fabrication (3)
MSE	513	NDE Methods and Analyses (3)
MSE	527/L	Mechanical Behavior of Materials and Lab (2/1)
MSE	528/L	Principles of Materials Engineering and Lab (2/1)

Quality and Management

MSE	504	Engineering Management (3)
MSE	601A	Engineering Statistics I (3)
MSE	604	Economic Analyses of Engineering (3)
MSE	617	Seminar in Quality Management (3)

3. Culminating Experience (3 units)

MSE	697MSE	Manufacturing Systems Directed Comprehensive Studies (3)

4. Advisor Approved Electives (12 units)

Recommended electives require faculty advisor guidance and approval, and can be selected from courses offered by the department, with the limitation of a maximum of two 400-level courses.

Other electives may be suitable for meeting individual student program goals.

Minor in Automation and CAD/CAM

Many professional career positions are in functional areas in which knowledge and skills in automation technology and in computer-aided design and manufacturing are an integral part of the product design and implementation processes. This minor is structured to augment undergraduate studies in engineering and related areas so as to facilitate student opportunities for access to and achievement in these professional career positions. Some students may find it necessary to complete selected prerequisite courses in mathematics, chemistry, physics, and/or engineering.

1. Required Courses (9 Units)

MSE	248/L	Engineering CAD and Graphics (2/1)
MSE	410/L	Manufacturing Systems Modeling and Lab (2/1)
MSE	409/L	Fundamentals of Computer-Aided Manufacturing and Lab (2/1)

2. Elective Courses (9 Units)

Each student must complete three elective courses that have been selected with the guidance of a faculty advisor. The courses selected are expected to be consistent with student background and interests, as well as program suitability and coherence. All electives must be approved **in advance** by the department.

Total Units Required for the Minor	18

Certificate In Quality Management

The Quality Management Certificate Program is designed for post baccalaureate individuals seeking access to or advancement in quality-related professions. Certified individuals will have knowledge of fundamental principles of quality management and control, lean processes, quality applications in project or service environments, and specialized quality management methods. Certified personnel will contribute to meeting industry and government needs for professionals in quality-related positions. The Quality Management Certificate Program is offered in collaboration with the Department of Systems and Operations Management.

A. Requirements for Admission

Admission to the Quality Management Certificate Program requires that applicants (1) hold an earned bachelor's degree from an accredited institution; (2) provide evidence of satisfactory completion of an undergraduate statistical methods course, such as SOM 307 or MSE 362, within four years of admission to the program; (3) provide evidence of basic work processing and spreadsheets software skills; and (4) be approved by the Department Graduate Coordinator.

B. Program Course Requirements

The Quality Management Certificate Program structured with six units of required coursework and nine units of restricted elective courses for a total of 15 semester units. There are two sets of restricted elective courses, and at least one 3-unit course must be selected from each set.

1. Required program core (6 units)

Select three units from:

SOM	467	Quality Management and Control (3)
SOM	667	Total Quality Management (3)

Complete the following course:

MSE	507	Lean Manufacturing Systems (3)

2. Program Electives (9 units)

Select at least three units from:

SOM	466	Project Management (3)
SOM	468	Managing for Service Excellence (3)
SOM	666	Project Planning and Policy (3)

Select at least three units from:

MSE	513	NDE Methods and Analysis (3)
MSE	514	Reliability and Maintainability (3)
MSE	601B	Engineering Statistics II (3)
MSE	617	Seminar in Quality Management (3)
MSE	618	Six Sigma Quality Engineering (3)

C. Certificate Program Completion Requirements

Criteria for the awarding of the Certificate in Quality Management are as follows:

1. Complete the 15 units of program course requirements with a minimum program GPA of 3.0.
2. Earn no grade lower than a B- in any individual course.
3. Satisfactorily complete all program course requirements within 3 years of program admission.
4. Submit application for the award of the certificate to the Department Graduate Coordinator.

Course List

MSE 101/L. Introduction to Engineering and Lab (1/1)

Corequisite: MSE 101L. Introduction to the engineering profession and academic programs. Orientation to the university, and the college and its departments. Development of study, communication, problem solving, design, analytical, and computing skills. Introduction to internet, word processing, spread sheet, computer-aided design, and presentation software. Design project development and team experience. One hour lecture-discussion and three hours lab per week. (Design units: 0.5)

MSE 105. Introduction to Computer-Aided Graphics Tools (3)

Introduction to the use of computer-aided (CA) graphics tools. Development of skills and techniques in graphical, pictorial and rotational representation. Students will be able to work on an individual project tailored to meet the needs of their field of study, and post their project on the Web. Not available for credit towards an engineering degree. (Available for General Education, Lifelong Learning.) (IC)

MSE 106. Introduction to CAD Animation (3)

Introduction to the use of tools to animate CAD and other objects. Development of skills and techniques to construct or import, and animate, 2- and 3-dimensional objects. Animation in an interactive environment. Students will be able to work on an individual project related to their field of study, and post the project on their own web page. Not available for credit towards an engineering degree. (Available for General Education, Lifelong Learning) (IC)

MSE 196A-Z. Experimental Topics Courses in Manufacturing Systems Engineering (1-4)

MSE 220/L. Construction Materials and Lab (2/1)

Prerequisite: PHYS 100A/L. Corequisite: MSE 220L. Introduction to basic construction materials and their properties: concrete, masonry, metals, woods, and thermal materials. Introduction to finishes, equipment, and specialty items. Not available for credit toward an engineering degree. Two hours lecture-discussion and three hours technical activity-lab per week.

MSE 227. Engineering Materials (3)

Prerequisite: MATH 150A; Preparatory: CHEM 101/L; PHYS 220A/L. Introductory course in engineering materials including metals, ceramics, polymers and composites. Study of atomic and crystalline structures of materials. Application of basic principles to study of mechanical, physical, and chemical behavior of materials. Selection of materials in engineering applications based on above criteria. Design project on materials properties, selection, or application. Three hours lecture per week. (Design units: 0.25)

MSE 227L. Engineering Materials Lab (1)

Prerequisite: MATH 150A; Preparatory: CHEM 101/L; PHYS 220A/L; MSE 227. Introductory lab course in engineering materials and their properties. Includes experiments in mechanical properties, heat treatment, metallography, corrosion properties and X-ray diffraction. Course culminates in a special project where students identify, design, and perform an experiment of their choosing. One 3-hour lab per week. (Design units: 0.25)

MSE 248/L. Engineering Cad and Graphics and Lab (2/1)

Prerequisite : MATH 250; Corequisite: MSE 248L. Development of concepts and skills in engineering graphics and computer-aided design (CAD). Reading, interpretation and preparation of working drawings; dimensioning and tolerances; interpretation of blueprints. Orthographic and isometric representations; auxiliary and sectional views. Three-dimensional solid modeling. Application of CAD graphics in the design and development of an assembly. two hours of lecture-discussion and three hours of lab per week. (Design units: 1.0)

MSE 292CS. MSEM Robotics Project (2-2-2)
Restricted to those students selected to participate in an MSEM Robotics Project. This course entails the application of engineering theory and practice to a robotics engineering project. Service and mentoring concepts, instruction, and practice are integral to the learning experience. This course offers a community service opportunity with activities relating to concepts and theories presented. May be repeated twice for credit. Six hours of lab per week.

MSE 296A-Z. Experimental Topics Courses in Manufacturing Systems Engineering (1-4)

Upper Division

MSE 300. Construction Technology Economy (3)
Prerequisites: ACCT 220; BLAW 280; ECON 160. Applications of engineering economy and capital investment analyses for construction management technology. Evaluation of project cash flows incorporating effective interest rates, inflation, price and wage rate changes, and uncertainty and risk. Considerations of national fiscal and monetary policy impact on project planning and analysis. Not available for credit toward an engineering degree. Three hours of lecture-discussion per week.

MSE 302. Women in Mathematics, Science and Engineering (3)
Prerequisite: Completion of lower division writing requirement. Exploration of the activities, contributions, and struggles of women in mathematics, science, engineering, and related areas and professions such as computer science. Research on individual women engaged in these fields. Investigation of different international, ethnic and culture-based practices and perspectives. Consideration of policy-related issues and intervention strategies addressing the participation and achievement of women in pertinent areas of study. (Available for General Education, Comparative Cultural Studies) (IC)

MSE 303. Innovation, Invention and Technology (3)
Prerequisite: Completion of lower division writing requirement. Exploration of the history, processes, methods, and creators of technological innovations and inventions. Global contributions, creator diversity, and technological failures are addressed. Critical assessments of technological innovation and invention. Not available for credit towards an engineering degree. (Available for General Education, Lifelong Learning.) (IC)

MSE 304. Engineering Economic Analysis (3)
Prerequisites: MATH 150B and completion of the Lower Division writing requirement. Systematic evaluation of the economic benefits and costs of projects involving engineering design and analysis. Economic decision-making in an environment of limited resources and uncertainty. Present economy, the economy of multi-year projects, selection among competing independent alternatives, sensitivity of outcomes to input parameters, before and after tax analyses, replacement economy, inflation and breakeven analysis in production environments. (Design units: 0.5)

MSE 362. Engineering Statistical Applications (3)
Prerequisites: Math 250 and CE 240. Development and application of probabilistic and statistical methods for selected classes of engineering design and analysis problems. Applications to product and structural design, engineering experiments and processes, and the reliability of engineering systems.

MSE 392. Undergraduate Research Program (3-3)
Prerequisite: Enrollment restricted to students selected to participate in the Undergraduate Research program. Course provides faculty mentoring and guidance to selected undergraduate students in the development of their research skills. The course includes a combination of lecture-discussion, lab experimental research, literature research, field work, research presentations, and other learning experiences. May be repeated for credit. (Design units: varies)

MSE 396A-Z. Experimental Topics Courses in Manufacturing Systems EngineerinG (1-4)

MSE 401. Introduction to Engineering and Technology Management (3)
Recommended preparatory: MSE 304 and MSE 362. An introduction to the roles of the engineer in managing engineering and technology activities. Responsibilities of engineering and technology managers, and transitioning into these roles. Challenges and risks in engineering and technology management. Available for graduate credit.

MSE 402. Engineering Project Management (3)
Prerequisite: MSE 362 or equivalent. The engineering project management process, from the feasibility stage through project close out. Topics include project initiation, project screening and selection, organizational and project structure, time and cost estimation, budgeting, developing work plans, scheduling resources, managing risk, tracking work, managing teams, partnership projects, and close out. Students learn to use appropriate software to assist with the project management process. (Design units: 0.5)

MSE 403CS. Facilities Planning and Design (3)
Prerequisite: MSE 319/L or equivalent, or graduate status. Basic concepts in the planning and design of manufacturing facilities; product analysis, manufacturing processes and equipment selection, and schedule design; flow, space, activity relationships and space planning; location and layout; material handling systems and facilities planning models. Offers a community service opportunity with activities relating to concepts and theories presented. (Design units: 1.5)

MSE 406. Engineering Cost Analysis (3)
Recommended preparatory: MSE 304 and MSE 362. Principles of cost analysis and estimating for the evaluation of engineering design and production, with emphasis on evaluating innovations and inventions. Case studies and practical application experiences. Available for graduate credit.

MSE 407. Manufacturing Systems (3)
Prerequisite: Instructor Consent. Principles, practices and methodologies of manufacturing systems. Effective design and implementation of manufacturing operations, production, control, quality, and automated systems. (Design units: 1.0)

MSE 409/L. Fundamentals of Computer-Aided Manufacturing and Lab (2/1)
Prerequisites: MSE 319/L or equivalent; or graduate status. corequisite: MSE 409L. Topics in computer-aided manufacturing (CAM). Fixed, programmable, and flexible automation; introduction to numerical control technology; manual NC programming; post-processing; graphical NC programming; NC programming with CAD/CAM systems. Selection and design of tooling. Two hours of lecture-discussion and three hours of lab per week. (Design units: 1.5)

MSE 410/L. Production Systems Modeling and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: MSE 410L. Design and analysis of production systems. Fixed, flexible, and programmable automation. Modeling and simulation of alternative production systems in conjunction with the systems design process. two hours of lecture-discussion; three hours of discussion and lab per week. Available for graduate credit. (Design units: 2.5)

MSE 412/L. Manufacturing Process and Lab (2/1)
Prerequisites: MSE 227/L, MSE 248/L and CE 240. Corequisite: MSE 412L. Manufacturing processes for cost-effective, high-quality production. Consideration of technical capabilities and limitations of alternative methods. Includes forming, removal, casting, joining, heat treating, molding, finishing, and coating. Course project required. Laboratory experiments include heat treating, deep drawing, powder metallurgy, casting, injection molding, fabricating composites, friction coefficients analysis, milled surface evaluation. Two hours lecture-recitation and three hours lab per week. Available for graduate credit. (Design units: 1.5)

MSE 415. Product Design (3)
Prerequisite: MSE 412/L; or graduate status. Engineering principles and practices of product design. Applications of process design for manufacturing engineering. Approaches to design for manufacture (DFM) and design for assembly (DFA). (Design units: 2.0)

MSE 488A. MSEM Senior Design I (2)
Prerequisite: Satisfactory completion of all major courses in years 1-3 of the 4-year program plan, permission of the instructor, and passing score on the UDWPE. Student teams engage in complex engineering design projects subject to multiple realistic constraints. Economic, environmental, social, political, ethical, health and safety, manufacturability, sustainability, and other relevant factors are addressed. Formal design reviews demonstrating written and oral communication skills are required. MSE 488A and MSE 488BCS must be completed during the same academic year. Six hours of laboratory per week. Not available for graduate degree program credit. Offered Fall semester. (Design units: 2.0)

MSE 488BCS. MSEM Senior Design II (2)
Prerequisite: MSE 488A. Continuation of MSE 488A. Includes a community service opportunity with activities relating to concepts and theories presented. MSE 488A and MSE 488BCS must be completed during the same academic year. Six hours of laboratory per week. Not available for graduate degree program credit. Offered spring semester. (Design units: 2.0)

MSE 492. Advanced Undergraduate Research Program (3-3-3-3)
Prerequisite: MSE 392; Enrollment restricted to students selected to participate in the Undergraduate Research Program. Course provides faculty mentoring and guidance to selected undergraduate students in the development of their research skills. The course includes a combination of lecture-discussion, lab experimental research, literature research, field work, research presentations, and other learning experiences. May be repeated for credit. (Design units: varies)

MSE 494A, B, C. Academic Internship (1, 2, 3)
Prerequisite: Senior or graduate standing in a major in the Department of Manufacturing Systems Engineering and Management, prior approval of the department internship coordinator, and in good standing as a matriculated student. Supervised practical professional experience relevant to the field of study in approved public or private organizations. Learning contracts and written reports required. Students may earn up to 3 units credit per semester and up to six units total. Units earned may not be used to fulfill major program requirements. (Credit/No Credit only)

MSE 496A-Z. Experimental Topics Courses in Manufacturing Systems Engineering (1-4)

MSE 498AA, AB, AC. Supervised Individual Project (1, 2 or 3)
Prerequisite: Instructor Consent. Individual student field study projects supervised by individual faculty.

MSE 499A-C. Independent Study (1-3)
Prerequisite: Senior or graduate standing in Manufacturing Systems Engineering, and written approvals of the faculty sponsor and the Department Chair. Admission is based on evidence of ability to pursue Independent Study in depth and approval of a proposal submitted prior to registration in the course. (Design units: varies)

Graduate

Note that 300-level courses in Manufacturing Systems Engineering do not carry credit for a Master's degree in Engineering.

MSE 504. Engineering Management (3)
Prerequisite: Instructor Consent. Principles and applications for effective management of technology projects, people, budgets and schedules. Organizing and motivating people, and controlling activities. Managing research, development, design, marketing and production functions in engineering and technology. Ethical considerations in engineering and technology management. (Design units: 0.5)

MSE 505. Engineering Decision Analysis (3)
Preparatory: MSE 362 or equivalent. Introduction to decision and risk analysis methods in the context of engineering. Organizing frameworks for the synthesis, analysis, and evaluation of complex unstructured engineering problems and situations. (Design units: 1.0)

MSE 507. Lean Manufacturing Systems (3)
Prerequisite: MSE 407 or consent of instructor. Concepts and principles of lean manufacturing systems. Methods and tools for application to manufacturing systems improvement. Practices and projects for effective design and implementation of lean manufacturing operation, production, control and quality systems.

MSE 508/L. CAD/CAM Systems and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: MSE 508L. Concepts and applications of computer aided design and manufacturing systems. Three-dimensional geometric modeling, surface and solid modeling, finite element modeling and analysis. Data exchange standards. Survey and evaluation of commercial CAD/CAM systems. Computer integrated manufacturing and management systems, and e-factory implementation. Emphasis on advanced modeling tools and applications. Two hours lecture-discussion; three hours lab per week. (Design units: 1.0)

MSE 509. Computer-Aided Manufacturing Systems (3)
Prerequisite: MSE 409/L or equivalent. Introduction to the design of computer-aided manufacturing systems. Concepts and principles of Computer-Aided Manufacturing programming languages development. Methods, tools, practices and projects for design and implementation of computer-aided manufacturing systems.

MSE 511/L. Robotics with Applications and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: MSE 511L. Fundamentals of robotics and robot applications. Topics include control system components, end effectors, sensors, programming, robotic cell design, and programmable automation. Two hours of lecture-discussion and three hours of lab per week. (Design units: 2.0)

MSE 512. Fundamentals of Mems Fabrication (3)
Prerequisite: Instructor Consent. Introduction to MEMS technology. Working principles of microsystems, engineering science for microsystem design and fabrication, materials for MEMS and microsystems, fabrication processes, micromanufacturing, packaging, CAD for MEMS design and assembly, CIM integration for fabrication.

MSE 513. NDE Methods and Analyses (3)
Prerequisite: Instructor Consent. Study of the methods of measuring quality in manufacturing products including metrology, and non-destructive evaluation (NDE) methods; radiographic, ultrasonic, surface examination, and acoustic emission. The capability limitations and economics of the methods of gathering and interpreting data for measurement of quality. Reliability engineering topics introduced. (Design units: 1.5)

MSE 514. Reliability and Maintainability (3)
Recommended preparatory: MSE 362 or equivalent. Reliability and maintainability as design parameters. Assessing and verifying design reliability, maintainability, and failure modes. Applications of reliability design methodology. (Design units: 1.0)

MSE 516/L. CAD/CAM Advanced Tools and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: MSE 516L. Advanced approaches to 2- and 3-dimensional computer-aided design and manufacturing. Part and assembly design, stress and mock-up using advanced tools such as CATIA. Design projects and applications. Two hours of lecture-discussion and three hours of lab per week.

MSE 517. CAD/CAM Advanced Applications and Lab (2/1)
Prerequisite: MSE 516/L or consent of instructor. Corequisite: MSE 517L. Examination and employment of advanced CAD/CAM tools throughout the product manufacturing life cycle. Applications to product and fabrication sequences modeling, and to the evaluation of product behavior during automated processes and assembly operations in the production system. Two hours of lecture-discussion and three hours of lab per week.

MSE 527/L. Mechanical Behavior of Materials and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: 527L. Relationships between mechanical behavior and materials structure. Elements of creep and fracture of metals, ceramics, and composites. Introduction to linear-elastic fracture mechanics and its application to design, and environmentally-assisted cracking lab methods for evaluating structural property relationships, fracture toughness measurements; engineering applications to the design of structures and pressure vessels. Fatigue analysis and failure analysis methods. Two hours lecture-discussion; three hours lab per week. (Design units: 1.0)

MSE 528/L. Principles of Materials Engineering and Lab (2/1)
Prerequisite: Instructor Consent. Corequisite: MSE 528L. Study of the principles governing the selection, treatment, and use of metals and alloys. Introduction to crystal structures, their imperfections and the effect on diffusion, phase transformations. The application of thermodynamic laws to metallic alloys; solid solutions; alloying and solubility in solids, metal/metal, metal/liquid, and metal/gas interactions. Two hours of lecture-discussion and three hours of lab per week. (Design units: 1.0)

MSE 531. Corrosion (3)
Prerequisite: Instructor Consent. Corrosion and oxidation, thermodynamics of corrosion, electrochemical fundamentals, aqueous corrosion, oxidation, kinetics of corrosion, corrosion rates, corrosion mechanisms, Wagner Theory of Oxidation, corrosion prevention. (Design units: 0.5)

MSE 536. Introduction to Advanced Biomaterials (3)
Prerequisite: Instructor Consent. The interaction between the human body environment and synthetic materials, including materials for medical implants and for dental restoration and appliances. Tissue engineering, biosensing, imaging, and drug delivery interact directly with biomaterials. Consideration of new technologies that depend upon overcoming present material limits and improving material/biological environment interactions.

MSE 550. Thin Film Technology (3)
Prerequisite: Instructor Consent. The basic processes for the deposition of films and coatings. Physical vapor deposition (PVD); evaporation, sputtering and ion plating, chemical vapor deposition (CVD) and plasma-assisted chemical vapor deposition (PACVD); electrodeposition and electroless plating. Thermal spraying, plasma spraying, and detonation gun technologies. The scientific background, basic processes, as well as relationships, and applications of each process will be discussed. (Design units: 0.5)

MSE 556. Nanomaterials and Nanotechnology (3)
Prerequisite: Instructor Consent. Introduction to nanotechnology and types nanomaterials that have been synthesized for applications in nanotechnology (mechanics, electronics, optoelectronics, energy and biomedical sciences). Illustration of the novel synthesis methods of various nanomaterials.

MSE 595A-Z. Experimental Topics Courses in Manufacturing Systems Engineering (1-4)

MSE 601A. Engineering Statistics I (3)
Prerequisite: Instructor Consent. Comprehensive statistical estimation, design and hypothesis testing methods, and their application to selected problems in engineering.

MSE 601B. Engineering Statistics II (3)
Prerequisite: MSE 601A or equivalent. Continuation of statistical methods and their applications in engineering, inclusive of fixed effects, randomized block, factorial, fractional factorial, regression, response surface, and random factors models.

MSE 602. Engineering Innovation Management (3)
Prerequisite: MSE 504 and MSE 608C; or equivalent. Starting, organizing, and managing engineering and technology research, design, and production. Technology and innovation, technological strategy and forecasting, technical entrepreneurship and intrapreneurship, evolving organizations, capitalization and intellectual property.

MSE 603. Computer Integrated Manufacturing (3)
Prerequisite: MSE 508/L or Instructor Consent. The integration of CAD/CAM, information management, and communication technologies in manufacturing environments. Provides advanced instruction in design and implementation of integrated CAD/CAM, robotics, and flexible manufacturing systems, with particular attention toward bridging information gaps. Topics include analysis of product definition processes, communication in manufacturing environments, technological and organization requisites for CIM, manufacturing requirements planning, just-in-time manufacturing, and future directions for factory automation.

MSE 604. Economic Analyses of Engineering (3)
Prerequisite: Instructor Consent. Evaluation of economic feasibility of large scale engineering systems. Projections of future economic environment, growth of demand, planned expansion of the system, use of resources, levels of confidence in projections, risk evaluation and profitability analysis.

MSE 606A. Engineering Operations Research I (3)
Prerequisite: Instructor Consent. Systems methodology and mathematical bases in industry. Selected approaches in optimization methods, such as linear, integer, and goal programming; assignment and transportation problems and inventory modeling; network optimization as well as PERT/CPM methods. Emphasis will be placed on the modeling and formulation of deterministic problems and the economic interpretation of results.

MSE 606B. Engineering Operations Research II (3)
Recommended preparatory: MSE 606A or equivalent. Continuation of selected approaches in systems optimization methods, such as stochastic, probabilistic, and waiting line models, with emphasis on applications to real-world problems.

MSE 607A. Seminar in Automation Engineering (3)
Prerequisite: Instructor Consent. Advanced studies of topics of current interest in automation engineering. The course consists in part of an intensive study of selected papers from current literature.

MSE 607B. Systems Engineering and Management (3)
Prerequisite: Instructor Consent. Overview of concepts and methods of systems engineering and management. Considerations of life cycles, requirements, and configuration and cost management. Standards, metrics, architectures, integration, and evaluation. Survey of relevant tools and techniques and their relationships to effective systems engineering management.

MSE 607C. Seminar in Manufacturing Systems (3)
Prerequisite: Instructor Consent. Advanced studies of topics of current interest in manufacturing systems. Course consists in part of the study of selected papers from current literature.

MSE 608A. Seminar in International Engineering Management (3)
Prerequisite: Instructor Consent. Advanced studies of topics relevant to international problems in the field of Engineering Management. Course consists in part of an intensive study of selected papers from current literature.

MSE 608A. Seminar in Engineering Management (3)
Prerequisite: Instructor Consent. Advanced studies of topics of current interest in the field of Engineering Management. Course consists in part of an intensive study of selected papers from current literature.

MSE 608B. Management of Engineering Professionals (3)
Prerequisite: MSE 504 or equivalent. Study of special considerations in the management of engineering professionals, including selection, performance, termination, and conflict situations. Course consists in part of the study of selected current publications.

MSE 608C. Engineering Financial and Cost Analysis (3)
Recommended preparatory: MSE 604 or equivalent. Fundamental concepts and methods of engineering financial cost analysis. Understanding the relevance of financial and managerial accounting to the effective management of engineering and technology projects.

MSE 609. Advanced Topics in CAD/CAM (3)
Recommended preparatory: MSE 508/L or equivalent. Areas of current interest in Computer-Aided Design and Manufacturing. Topics include computer graphics software and hardware, mathematical bases of geometric modeling, simultaneous engineering, manufacturability analysis, feature-based processing, and database management for manufacturing environments.

MSE 611. Robotics and Programmable Automation (3)
Prerequisite: Consent of instructor. Recommended preparatory: MSE 511/L. Introduction to the design of programmable automation with robotic applications. Concepts, principles and applications of programmable automation in manufacturing environments. Methods, tools, practices and projects for design and implementation of programmable automation systems.

MSE 612. Seminar in Advanced Manufacturing Technologies (3)
Prerequisite: Instructor Consent. Advanced studies of topics of current interest in advanced manufacturing technologies. Course consists in part of an intensive study of selected papers from current literature.

MSE 614. Intelligent Manufacturing (3)
Prerequisite: Consent of Instructor. Software and methodologies for integrating intelligence into manufacturing, such as artificial intelligence and expert systems, fuzzy logic, agent software, case-based reasoning, feature-recognition, intelligent maintenance and monitoring. Methods of capturing expertise and knowledge for developing intelligent systems. Development of knowledge-based systems. Understand examples of intelligent manufacturing available in industry.

MSE 617. Seminar in Quality Management (3)
Recommended preparatory: MSE 362 or equivalent. Discussion and analysis of current theory, practices, and state-of-the-art developments applicable to quality management in engineering and technology. MSE

MSE 618. Six Sigma Quality Engineering (3)
Prerequisite: MSE 601 or Consent of Instructor. Overview and evolution of continuous improvement methodologies. Comparison of product-related and process-related six sigma methodologies. Integration of operating philosophies, applied statistics, and project management in continuous improvement deployment. Phases of six sigma methodology and application of computing technologies to quality engineering projects. Advanced topics in six sigma continuous improvement design.

MSE 622. Fracture Mechanics (3)
Prerequisite: Instructor Consent. Introduction to linear-elastic fracture mechanics and its application to design. Analytical and numerical methods for the calculation of crack tip stress intensity. Engineering applications to the design of structures and pressure vessels. Fatigue analysis methods.

MSE 623. Composite Materials (3)
Prerequisite: Instructor Consent. Introduction to the structural and materials properties of composites. Static and dynamic characteristics. Stress analysis. Environmental and manufacturing effects on composites. Methods of testing composites.

MSE 624. Failure Analysis (3)
Prerequisite: Instructor Consent. Modes, mechanisms, models and theories of materials failures. Environmental-assisted cracking and fatigue of materials. Analyses of engineering failures. Emphasis is placed on the development and formulation of approaches to materials selection based on probable failure modes.

MSE 628. Applied Metallurgical Thermodynamics (3)
Prerequisite: Instructor Consent. Application of thermodynamic laws to metallic alloys; solid solutions; alloying and solubility in solids, metal/metal, metal/liquid and metal/gas interactions; electrochemical processes in metals; defect structure of metals and metallic alloys; applications.

MSE 629. Phase Transformations (3)
Prerequisite: Instructor Consent. Thermodynamics of phase transformations, kinetics of reactions, diffusion, crystal growth, solidification, recovery, recrystallization and grain growth, solid state phase transformation, diffusional and martensitic transformations.

MSE 630. Electronic Materials (3)
Prerequisite: Instructor Consent. Electrical behaviors of materials; conductors, semiconductors and insulators; electronic structure of materials; preparation of semiconductor materials; crystal growth and doping; intrinsic and extrinsic semiconductors; semiconductor devices; superconductivity and superconducting materials; photoelectron effects with semiconductors; photovoltaic materials and solar cells; imperfections in semiconductors; characterization of electronic materials.

MSE 649. Seminar in Engineering Materials (3)
Advanced studies of topics of current interest in the field of engineering materials. Consists in part of an intensive study of selected papers from current literature.

MSE 690. Materials Engineering Research Practicum (3)
Prerequisite: Instructor Consent. Applications of advanced materials and processes engineering laboratory research techniques and methodologies to studies of current interest, such as nanotechnology, MEMS, sensors, smart materials, microelectronics, optoelectronics, bio-materials, or environmentally-assisted cracking of advanced materials.

MSE 691. Automated Systems Practicum (3)
*Prerequisite: Instructor Consent.*Application of advanced engineering principles to automated systems. Research and methodologies of current interest, such as intelligent manufacturing, modern manufacturing automation, automated systems management, automated assembly and disassembly, and the factory of the future.

MSE 692. Engineering Management Research Practicum (3)
Prerequisites: Completion of at least 18 units in formal program of study with GPA of at least 3.75, classified status and consent of instructor. Application of advanced concepts of current interest in engineering management to research and implementation in technology-based environments, such as analytical methods, production systems, technical personnel, innovation, and cost analyses.

MSE 695A-Z. Experimental Topics Courses in Manufacturing Systems Engineering (1-4)

MSE 696A-C. Directed Graduate Research (1-3)
Prerequisite: MSE 698 and approvals of the faculty advisor and either the Department Graduate Coordinator or the Department Chair. (Credit/No Credit Only)

MSE 697. Directed Comprehensive Studies (3)
(Credit/No Credit Only)

MSE 697MFS. Manufacturing Systems Directed Comprehensive Studies (3)
Preparatory: Classified status in M.S. Manufacturing Systems Engineering, satisfactory completion of at least 24 semester units in formal program of study, and supervising faculty advisor and Graduate Coordinator permission. Preparation for and completion of written and oral comprehensive culminating experience requirement for the Master of Science in Manufacturing Systems Engineering degree. (Credit/No Credit Only)

MSE 697MGT. Engineering Management Directed Comprehensive Studies (3)
Preparatory: Classified status in M.S. Engineering Management, satisfactory completion of at least 27 semester units in formal program of study, and supervising faculty advisor and Graduate Coordinator permission. Preparation for and completion of written comprehensive case studies culminating experience requirement for the Master of Science in Engineering Management degree. (Credit/No Credit Only)

MSE 697MTL Materials Engineering Comprehensive Directed Studies (3)
Preparatory: Classified status in M.S. Materials Engineering, satisfactory completion of MSE 690, and permission from supervising faculty advisor and Department Graduate Coordinator. Preparation for and completion of written comprehensive examination culminating experience requirement for the Master of Science in Materials Engineering degree. (Credit/No Credit Only)

MSE 698A-C. Thesis or Graduate Project (1-6)
Prerequisite: Advancement to candidacy for the MS degree and written approvals of the faculty advisor and the Department Graduate Coordinator or the Department Chair.

MSE 699A-C. Independent Study (1-3)
Prerequisite: Classified status in MS program and written approvals from faculty sponsor and Department Graduate Coordinator or the Department Chair. Admission is based in part on evidence of the ability to pursue Independent Study or research in depth and approval of a proposal submitted prior to the time of registration.