Materials Science and Engineering

Degree Offered: PhD, MSME
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Admission Requirements

In addition to the general Graduate School admission requirements, requirements for admission to the MSME and PhD. graduate programs include the following criteria:

1. A 3.0 (A = 4.0) or better GPA on all undergraduate degree major courses attempted.

2. Submission of GRE scores:
   a. For applicants to the MSME program, the GRE general test is required for all applicants who did not receive a BS degree from a program accredited by the Engineering Accreditation Committee of ABET http://www.abet.org, or from other programs with reciprocal agreement under the Washington Accord http://www.ieagreements.org/accords/washington/.
   b. For applicants to the PhD program, the GRE general test is required for all applicants. Applicants must score a 156 or higher on the quantitative section of the GRE to be considered for admission.

3. In addition, a minimum score of 80 on the TOEFL, 20 on each subscore, or a 6.5 on the IELTS is required for international applicants whose native language is not English.

Early Acceptance

Early Acceptance Programs are designed for academically superior high-school students. Early Acceptance Programs allow high achieving students to be admitted to the Materials Engineering program at the same time they are admitted to an undergraduate program.

Eligible students are required to maintain a 3.5 undergraduate GPA and complete the following pre-requisite courses: EGR 265 or MA 227, MSE 280, MSE 281, MSE 380, MSE 381, MSE 382.

Preparatory Content

A student seeking a graduate degree in Materials must demonstrate competence at the undergraduate level in the areas of engineering materials, physical behavior of materials, thermodynamics, and mechanical behavior of materials. Students may be exempted from individual courses or examination if they demonstrate that they possess the knowledge from that course, usually with a grade of a “B” or better. However, the burden of proof is on the student. He/she may accomplish this by passing a pre-requisite examination on the portion of the following course content depending on the student's academic background. The courses that fulfill the preparatory requirements are:

- MSE 280: Engineering Materials
- MSE 281: Physical Materials I
- MSE 380: Thermodynamics of Materials
- MSE 381: Physical Materials II
- MSE 382: Mechanical Behavior of Materials

Additional Information

Deadline for Entry Term(s): Each semester and summer
Deadline for All Application Materials to be in the Graduate School Office - Fall Semester: August 31st
Deadline for All Application Materials to be in the Graduate School Office - Spring Semester: March 1st
Number of Evaluation Forms Required: Three
Entrance Tests: GRE (TOEFL and TWE also required for international applicants whose native language is not English.)

Comments:

Master of Science in Materials Engineering Program

The following minimum requirements for a Master of Science in Materials Engineering apply to a student who has earned a baccalaureate degree from a program accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org, in materials or metallurgical engineering or in a similarly named engineering program. A student with an undergraduate degree in another field of engineering or in the physical sciences may also be accepted into the Materials Engineering program. All students will be required to demonstrate competence in fields of study that emphasize the interrelationship among structure, processing, performance, and properties of materials. This can be accomplished by one of the methods described under "Preparatory Courses."

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined hours of Special Topics and/or Independent Study courses will be applied to the MSMe without appeal to and approval from the Program Director.

Plan I (Thesis Option)

The student must successfully complete at least 35 semester hours of (primarily) materials engineering graduate work including 26 hours of courses and 9 hours of MSE 699 Thesis Research.

- Of these 26 hours, 3 to 6 semester hours will be approved courses in mathematics, physical sciences, another engineering discipline or management (a maximum of 3 hours are allowed in management).
- Up to 9 of the 26 hours may be at the MSE 500 level. If a student has completed the undergraduate equivalent at UAB, another MSE 500 level course should be completed in its place.
- A full time graduate student is required to register for 1 credit hour of MSE 601 Materials Science and Engineering Seminar for fall and spring semester, up to 2 hours of seminar can be applied for credit.
• Successful completion of a Masters Thesis Research Proposal following the NSF Proposal Preparation and Submission Guidelines and examination on topics related to the student’s research. (Completion of this step is required for registration of MSE 699 Thesis Research).

• The student must successfully complete and defend a thesis. The thesis must be sent to a department approved proofreader and edits must be incorporated into the final submission.

• The student must register for and successfully complete at least 9 semester hours of MSE 699 Thesis Research in addition to the 26 semester hours of course work.

Plan II (Non-thesis Option): Research/Design Emphasis

The student must successfully complete at least 35 semester hours of (primarily) materials engineering graduate work including 32 hours of courses and 3 hours of MSE 698 Non-Thesis Research

• Of these 32 hours, 3 to 6 semester hours will be approved courses in mathematics, physical sciences, another engineering discipline or management (a maximum of 3 hours are allowed in management).

• Up to 9 of the 26 hours may be at the MSE 500 level. If a student has completed the undergraduate equivalent at UAB, another MSE 500 level course should be completed in its place).

• A full time graduate student is required to be registered for 1 credit hour of MSE 601 Materials Science and Engineering Seminar for fall and spring semester, up to 2 hours of seminar can be applied for credit.

• The student must complete 3 semester hours of MSE 698 Non-Thesis Research, involving an on-site research project (usually taken after completion of all coursework).

Plan II (Non-thesis Option): Fast Track, Fifth Year

This plan is open to undergraduate students in materials engineering within 48 hours of graduation with at least 15 hours of coursework completed at UAB. The student must successfully complete at least 35 semester hours of (primarily) materials engineering graduate work.

• Of these 35 hours, 15 to 21 hours are required within the MSE department at the graduate level.

• Of these 35 hours, 9 to 12 hours of business related courses – students may focus these courses in several areas; business administration, management entrepreneurship, or engineering liability/law.

• Of these 35 hours, 0 to 6 hours may be completed by participation in an internship opportunity. This is an option and not a requirement. If internships are conducted for credit, each discipline will have requirements associated with the internship.

• A full time graduate student is required to be registered for 1 credit hour of MSE 601 Materials Science and Engineering Seminar for fall and spring semester, up to 2 hours of seminar can be applied for credit.

• Students are expected to complete at least two graduate courses during their senior year so that the masters can be completed in a one-year time period.

Plan II (Non-thesis Option): Technology/Engineering Management Emphasis

The student must successfully complete at least 35 semester hours of (primarily) materials engineering graduate work.

• 12 semester hours of course work in a specific area of materials science and engineering (at least 6 of these 12 hours must be at the 600 level).

• 6 semester hours of approved management course work.

• 9 semester hours of engineering-oriented management coursework.

• 3 hours of MBA 631 Management and Organizations.

• The student must also complete 3 semester hours of involving an on-site design or research project (usually undertaken after completion of all course work).

• A full time graduate student is required to be registered for 1 credit hour of MSE 601 Materials Science and Engineering Seminar for fall and spring semester, up to 2 hours of seminar can be applied for credit.

PhD Program

The PhD program in Materials Engineering is offered jointly with the Department of Metallurgical and Materials Engineering at the University of Alabama (Tuscaloosa).

The following minimum requirements for a PhD in materials engineering apply to a student who has earned a baccalaureate degree from a program accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org, in materials or metallurgical engineering or in a similarly named engineering program. A student with an undergraduate degree in another field of engineering or in the physical sciences may also be accepted into the Materials Engineering program. All students will be required to demonstrate competence in fields of study that emphasize the interrelationship among structure, processing, performance, and properties of materials. This can be accomplished by one of the methods described under “Preparatory Courses.” A graduate student committee must be formed for all PhD candidates and one faculty member from UA Materials Engineering Program must be included.

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined hours of Special Topics and/or Independent Study courses will be applied to the PhD without appeal to and approval from the Program Director.

PhD Track (For students entering with a BS):

The requirements for a PhD student must complete 81 semester hours of (primarily) materials engineering graduate work as a requirement when entering with a BS degree:

• A minimum of 57 hours of approved graduate course work in metallurgical engineering, materials engineering, or fields supportive of these

• 15 hours may be at the MSE 500 level and is required for all students unless they completed the undergraduate equivalent at UAB (in which case another MSE 500 level course should be completed in its place).

• At least 6 semester hours but no more than 12 must be in supportive fields (a maximum of 6 hours can be in management). Additional
course work may be required at the discretion of the mentor and program director.

- A full time graduate student is required to be registered for 1 credit hour of MSE 701 Materials Science and Engineering Seminar for fall and spring semester, up to 6 hours of seminar can be applied for credit.
- A student may apply 6 hours of MSE 798 Non dissertation Research can be applied for credit toward the 57 hour course requirement.
- Successful completion of a Dissertation Research Proposal following the NSF Proposal Preparation and Submission Guidelines and examination on topics related to the student’s research. (Completion of this step is required for Admission to Candidacy).
- A minimum of 24 semester hours in MSE 799 Dissertation Research.
- Successful defense of a research dissertation in metallurgical / materials engineering.
- The dissertation must be sent to a department approved proofreader and edits must be incorporated into the final submission.
- For students entering the PhD program with a BS degree, it is expected that they will be able to earn a plan II masters degree after completing the required coursework for the degree.

**PhD Track (For students entering with a MS):**

This track is for students entering the program with a master’s degree in Materials Engineering or a closely related field.

The PhD student must complete 51 semester hours of (primarily) materials engineering graduate work as a requirement when entering with a MS degree

- A minimum of 27 hours of approved graduate course work in metallurgical engineering, materials engineering, or fields supportive of these
- 6 hours may be at the MSE 500 level is required for all students unless they completed the undergraduate equivalent at UAB (in which case another MSE 500 level course should be completed in its place).
- At least 3 semester hours but no more than 6 must be in supportive fields (a maximum of 3 hours can be in management). Additional course work may be required at the discretion of the mentor and program director.
- A full time graduate student is required to be registered for 1 credit hour of MSE 701 Materials Science and Engineering Seminar for fall and spring semester, up to 4 hours of seminar can be applied for credit.
- A student may apply 6 hours of MSE 798 Non dissertation Research can be applied for credit toward the 27 hour course requirement.
- Successful completion of a Dissertation Research Proposal following the NSF Proposal Preparation and Submission Guidelines and examination on topics related to the student’s research. (Completion of this step is required for Admission to Candidacy).
- A minimum of 24 semester hours in MSE 799 Dissertation Research.
- Successful defense of a research dissertation in metallurgical / materials engineering.
- The dissertation must be sent to a department approved proofreader and edits must be incorporated into the final submission.

**Courses**

**MSE 501. Materials Processing. 3 Hours.**
Processing of metals, glasses, ceramics, and composites. Powder, casting, welding, rapid solidification, and other advanced approaches.

**MSE 505. Frontiers of Automotive Materials. 3 Hours.**
Advanced lightweight automotive materials, manufacturing and modeling techniques. Technology advancements in cost-effective carbon, glass and related reinforcements; “green” and sustainable materials, crashworthiness and injury protection of occupants and pedestrians, metal castings, heavy truck, mass transit, fuel cell and hybrid vehicles. Students taking this class will receive a GATE certificate of training in automotive materials technologies upon successful completion.

**MSE 508. Nanobiomaterials. 3 Hours.**
Basic tools of nanotechnology, building blocks of nanostructured materials. Behavior of materials with nanoscale structures and their technological applications, including automotive, medical, and electronic applications. Introduction to biomaterials and nanobiomaterials. Concepts in tissue engineering with special focus on nanoscaffolds and nanoparticles in drug delivery.

**MSE 509. Principles of Metal Casting. 3 Hours.**
Production and evaluation of cast ferrous metals (gray iron, ductile iron, steel) and non-ferrous metals (brass, bronze, aluminum). Design of castings and molds. Laboratory on the gating, risering and molten metal treatment, analysis and handling techniques required to produce high quality castings. MSE 280 is recommended.

**Prerequisites:** MSE 280 [Min Grade: D]

**MSE 509L. Principles of Metal Casting. 0 Hours.**
Laboratory component of MSE 509 and must be taken concurrently.

**MSE 513. Composite Materials. 3 Hours.**
Processing, structure, and properties of metal-, ceramic-, and polymer-matrix composite materials. Roles of interfacial bond strength, reinforcement type and orientation and matrix selection in physical and mechanical properties of composite materials.

**MSE 530. Polymeric Materials. 3 Hours.**
Processing methods, structure/engineering/property relationships, and applications of polymeric materials.

**MSE 530L. Polymeric Materials Lab. 0 Hours.**
Laboratory component of MSE 530 and must be taken concurrently.

**MSE 533. Nondestructive Evaluation of Materials. 3 Hours.**
Principles, applications, and limitations of ultrasonic vibrations, acoustic emission, radiographic, magnetic particle, eddy current, and other nondestructive testing methods. Intelligent sensors and health monitoring of real structures.

**MSE 545. The Evolution of Engineering Materials. 3 Hours.**
Past, present and future of engineering materials; how new materials and processing methods have impacted human society, from the Stone Age until today. Taught as a 3-week study abroad course in Germany, with visits to universities, industrial facilities, research labs, museums and selected cultural sites.

**MSE 552. Composites Manufacturing. 3 Hours.**
Principles of manufacturing and processing of polymeric matrix composites. Production techniques including filament winding, pultrusion, and liquid infusion techniques combined with design, environmental and manufacturing issues of polymer matrix composites.

**MSE 554. Metals and Alloys. 4 Hours.**
Microstructures, properties, heat treatment, and processing of ferrous and nonferrous materials.
MSE 564L. Metals and Alloys Lab. 0 Hours.
Laboratory component of MSE 564 and must be taken concurrently.

MSE 565. Characterization of Materials. 4 Hours.
Theory and practice of materials characterization, with emphasis on optical metallography, quantitative metallography, scanning electron microscopy, crystallography, and x-ray diffraction. Specific application in metals and ceramics considered.

MSE 565L. Characterization of Materials Laboratory. 0 Hours.
Laboratory component of MSE 565 and must be taken concurrently with MSE 565.

MSE 570. Ceramic Materials. 4 Hours.
Structure, processing, properties, and uses of ceramic compounds and glasses. Mechanical, thermal, and electrical behavior of ceramic materials in terms of microstructure and processing variables.

MSE 570L. Ceramic Materials Laboratory. 0 Hours.
Laboratory component of MSE 570 and must be taken concurrently.

MSE 574. Metals and Alloys II. 3 Hours.
Production and physical metallurgy of ferrous and non-ferrous alloys including: steel alloys, inoculation and production of ductile, gray, compacted and malleable iron; advanced heat treatments of steel and iron; conventional and ultra-high strength aluminum alloys; wrought and cast copper alloys; wrought and cast magnesium alloys.

MSE 590. Special Topics in (Area). 1-6 Hour.
Special Topics in Area.

MSE 591. Individual Study in (Area). 1-6 Hour.
Independent study allows the student to explore a topic of interest under the close supervision of a faculty member. The course may include directed readings, applied work, assisting a faculty member with a research project, carrying out an independent research project, or other activities deemed appropriate.

MSE 601. Materials Science and Engineering Seminar. 1 Hour.
Required of all full-time masters students.

MSE 602. Intro to Thermodynamics and Mechanics of Materials. 2 Hours.
This course is a survey of undergraduate level theory and application of the fundamental principles of mechanics of materials and thermodynamics. Understanding is based on the explanation of the physical behavior of materials under load and then modeling this behavior to develop the theory. Intended to provide the students with both the theory and application of the fundamental principles of thermodynamics of materials. Students must be graduate student in engineering, chemistry or physics.

MSE 603. Thermodynamics of Materials. 3 Hours.
Atomistic and classical approaches to the understanding of the thermodynamics of solids, phase transformations, chemical reactions, and alloy systems.

MSE 605. Introduction to Physical Materials. 2 Hours.
Overview of fundamental concepts of materials science and engineering, focusing on chemical and physical properties such as bonding, crystal structure and defects, diffusion, and phase diagrams.

MSE 606. Introduction to Manufacturing Engineering. 3 Hours.
Manufacturing is the process of transforming raw materials into products. Even the most optimized and controlled industrial processes are fraught with variability and inefficiencies, both of which can have a negative impact on profitability. This course will introduce students to the proven tools to characterize and optimize industrial processes. In addition, students will learn the statistical techniques to quantitative assess and detect changes to a process and make data-driven decisions to improve that process.

MSE 607. Measurement Systems Analysis. 3 Hours.
Whether in a manufacturing process, research & development lab or quality control, assessment and analysis of data used for decision making has roots in the equipment and procedures that make up a measurement system. Students will learn to critically assess the capability of measurements systems, gauges and analytical equipment used to collect data. Students will learn metrology, best practices, and statistical tools to quantitatively assess, as well as procedures to implement a Gage R&R study to improve a measurement system. In addition, students will learn effective communication strategies for presenting the results of statistical analysis.

MSE 608. Process Characterization and Advanced Statistical Analysis. 3 Hours.
This course centers on manufacturing processes and the inherent variability of all products. Product variability has origins at all input points in a process; raw materials, energy, time, human, etc. This course will expose engineers to the statistics to quantify and assess variability. In addition to statistical tools, we will delve deep into all phases of the DMAIC (Define, Measure, Analysis, Improve, and Control) methodology and the Lean/Six Sigma tools to identify, implement and document process improvements. An emphasis will be placed on the communication of these often-complicated statistics in an industrial setting. We will put these concepts into practice through completion of a final term paper. Students will be required to choose an industrial process and apply and communicate the concepts learned in this course.

MSE 610. Advanced Materials, Manufacturing and Applications Development. 3 Hours.
Introduction to advanced materials by design, near net-shape cost-effective manufacturing, synergistic knowledge of material properties, durability and function. Hands on activities related to extrusion-compression, fiber spinning, thermoset/thermoplastic materials, medical grade materials, intermediate forms and hybrid manufacturing. Integrated process and product development methodology. Student projects will involve manufacturing processes associated with mass production.

MSE 613. Mechanical Behavior of Materials. 3 Hours.
Microstructural effects on the deformation mechanisms responsible for mechanical behavior of engineering materials.

MSE 614. Process Quality Engineering. 3 Hours.
Application of the concepts and tools of total quality to develop, implement, and maintain an effective quality assurance system in a materials processing and manufacturing environment. Students will be exposed to probability models, statistical tools, linear and multiple regression, DOE, TQM and six sigma.

MSE 624. Physical Metallurgy. 3 Hours.
Course will consider the fundamental thermodynamic and kinetic principles governing the behavior of metals and alloys, particularly with respect to their influence the formation and evolution of microstructure. Topics will include liquid-solid and solid-state phase transformations, nucleation, growth, solidification and diffusion.
MSE 628. Thermal Characterization. 3 Hours.
This lab-oriented course will be focused to give graduate students the theory and hands-on experience in operation, data acquisition and interpretation of widely used thermal characterization techniques such as differential scanning calorimeter (DSC), thermogravimetric analyzer (TGA), Simultaneous TGA-DTA, Thermo mechanical analyzer (TMA), Dynamic mechanic analyzer (DMA) and rheological and viscosity analyses of polymeric resins and composite materials. Exposure to the surface characterization techniques such as contact angle goniometer for wettability, Fourier Transform infrared spectrometer (FT-IR) and X-ray-photoelectron spectroscopy (XPS) for surface chemical analyses and atomic force microscopy for roughness and morphology.

MSE 628L. Thermal Characterization Lab. 0 Hours.
Laboratory component of MSE 628 and must be taken concurrently.

MSE 629. Polymer Structure and Morphology. 3 Hours.
Polymer structures and morphology and it's relationships with applications, multicomponent polymer systems (polymer blends, copolymers, micro and nanocomposites), liquid crystalline polymers, polymer crystals, oriented polymers, morphological aspects of deformation and advances in polymers (biomimetic and bioinspired polymer systems).

MSE 633. Advanced Mechanics of Deformation. 3 Hours.
Basics and intermediate mechanics of deflection of beams and columns, mechanics of impact, failure theories, plastic deformation of materials, fracture mechanics, fatigue, creep and vibration. The topics will be supported by industry relevant case studies. Suggested prerequisites included Mechanics of Solids (CE 220) and Mechanical Behavior (MSE 382).

MSE 635. Advanced Mechanics of Composites. 3 Hours.
Classical lamination theory, analysis and failure of reinforced composite material systems, anisotropic elasticity, stress analysis and design of laminated composites including 3D effects, stress concentrations, free-edge effects, hygrothermal behavior, adhesive and mechanical connections.

MSE 636. Engineering Fibers. 3 Hours.
Processing-microstructure-properties of different fibrous materials: natural polymeric fibers (jute, sisal, silk, etc.), synthetic polymeric fibers (aramid and polyethylene, etc.), metallic fibers, and high performance ceramic fibers (alumina and silicon carbide). Application of Weibull statistics to strength of fibrous materials, techniques of mechanical testing of fibers and applications of fibers in various fields.

MSE 638. Degradation of Materials. 3 Hours.
Basics of materials degradation- thermodynamics and kinetics - Pourbaix diagram, chemical and electrochemical reactions; Degradation types and mechanisms; Degradation of different material systems: Metals, alloys, ceramics and glasses, polymers and composites for versatile applications- structural, functional, energy and biomedical; Impact on materials properties; Investigation for materials degradation; Protection from degradation and materials design; Environmental and biological aspects; Societal impact.

MSE 667. Process Modeling/Simulation. 3 Hours.
Theory and practice of analytical methods and computational modeling for manufacturing processes of metals, ceramics, polymers and composites. Applications on processes such as metal cutting, welding, casting, massive forming, solidification, rapid prototyping, injection molding and resin transfer molding.

MSE 668. Applied Finite Element Analysis. 3 Hours.
Finite Element Analysis (FEA) is used widely for design optimization and failure prediction in automobile, energy, aerospace, and other industries. This course primarily looks at how practically to set up static structural models and get meaningful results. The focus will be on applying loading and boundary conditions, good meshes, convergence of results, and correct interpretation of results. Students will learn how to set up models using programs such as Pro/Engineer and ANSYS.

MSE 669. Degradation of materials. 3 Hours.
The course will introduce the thermodynamics and kinetics of materials degradation; degradation mechanisms and types; degradation of different material systems (metals, alloys, ceramics and glasses, polymers and composites) for multifaceted applications; protection from degradation and materials design; Environmental and biological aspects; societal impact.

MSE 670. Physical Characterization. 3 Hours.
Theory and practice of materials characterization, with emphasis on optical metallography, quantitative metallography, scanning electron microscopy, crystallography, and x-ray diffraction. Specific application in metals and ceramics considered.

MSE 690. Special Topics In (Area). 1-6 Hour.
Special Topics in (Area).

MSE 690L. Special Topics in (Area) Laboratory. 0 Hours.
Special Topics in (Area) laboratory.

MSE 691. Individual Study In (Area). 1-6 Hour.
Individual Study in (Area).

Non-Thesis Research.

Prerequisites: GAC M

MSE 701. Materials Science and Engineering Seminar. 1 Hour.
Materials Science and Engineering Seminar. Required of all full-time doctoral students.

MSE 702. Intro to Thermodynamics and Mechanics of Materials. 2 Hours.
This course is a survey of undergraduate level theory and application of the fundamental principles of mechanics of materials and thermodynamics. Understanding is based on the explanation of the physical behavior of materials under load and then modeling this behavior to develop the theory. Intended to provide the students with both the theory and application of the fundamental principles of thermodynamics of materials. Students must be graduate student in engineering, chemistry or physics.

MSE 703. Thermodynamics of Materials. 3 Hours.
Atomistic and classical approaches to the understanding of the thermodynamics of solids, phase transformations, chemical reactions, and alloy systems.

MSE 705. Introduction to Physical Materials. 2 Hours.
Overview of fundamental concepts of materials science and engineering, focusing on chemical and physical properties such as bonding, crystal structure and defects, diffusion, and phase diagrams.
MSE 710. Advanced Materials, Manufacturing and Applications Development. 3 Hours.
Introduction to advanced materials by design, near net-shape cost-effective manufacturing, synergistic knowledge of material properties, durability and function. Hands on activities related to extrusion-compression, fiber spinning, thermoset/thermoplastic materials, medical grade materials, intermediate forms and hybrid manufacturing. Integrate process and product development methodology. Student projects will involve manufacturing processes associated with mass production.

MSE 714. Process Quality Engineering. 3 Hours.
Application of the concepts and tools of total quality to develop, implement, and maintain an effective quality assurance system in a materials processing and manufacturing environment. Students will be exposed to probability models, statistical tools, linear and multiple regression, DOE, TQM and six sigma.

MSE 724. Physical Metallurgy. 3 Hours.
Course will consider the fundamental thermodynamic and kinetic principles governing the behavior of metals and alloys, particularly with respect to their influence the formation and evolution of microstructure. Topics will include liquid-solid and solid-state phase transformations, nucleation, growth, solidification and diffusion.

MSE 728. Thermal Characterization. 3 Hours.
This lab-oriented course will be focused to give graduate students the theory and hands-on experience in operation, data acquisition and interpretation of widely used thermal characterization techniques such as differential scanning calorimeter (DSC), thermo gravimetric analyzer (TGA), Simultaneous TGA-DTA, Thermo mechanical analyzer (TMA), Dynamic mechanic analyzer (DMA) and rheological and viscosity analyses of polymeric resins and composite materials. Exposure to the surface characterizations techniques such as contact angle goniometer for wettability, Fourier Transform infrared spectrometer (FT-IR) and X-ray-photoelectron spectroscopy (XPS) for surface chemical analyses and atomic force microscopy for roughness and morphology.

MSE 728L. Thermal Characterization Lab. 0 Hours.
Laboratory component of MSE 728 and must be taken concurrently.

MSE 729. Polymer Structure and Morphology. 3 Hours.
Polymer structure and morphology and it's relationships with applications, multicomponent polymer systems (polymer blends, copolymers, micro and nanocomposites), liquid crystalline polymers, polymer crystals, oriented polymers, morphological aspects of deformation and advances in polymers (biomimetic and bioinspired polymer systems).

MSE 733. Advanced Mechanics of Deformation. 3 Hours.
Basics and intermediate mechanics of deformation of beams and columns, mechanics of impact, failure theories, plastic deformation of materials, fracture mechanics, fatigue, creep and vibration. The topics will be supported by industry relevant case studies. Suggested prerequisites included Mechanics of Solids (CE 220) and Mechanical Behavior (MSE 382).

MSE 735. Advanced Mechanics of Composites. 3 Hours.
Classical laminated theory, analysis and failure of reinforced composite material systems, anisotropic elasticity, stress analysis and design of laminated composites including 3D effects, stress concentrations, free-edge effects, hygrothermal behavior, adhesive and mechanical connections.

MSE 736. Engineering Fibers. 3 Hours.
Processing-microstructure-properties of different fibrous materials: natural polymeric fibers (jute, sisal, silk, etc.); synthetic polymeric fibers (aramid and polyethylene, etc.); metallic fibers, and high performance ceramic fibers (alumina and silicon carbide). Application of Weibull statistics to strength of fibrous materials, techniques of mechanical testing of fibers and applications of fibers in various fields.

MSE 738. Degradation of Materials. 3 Hours.
Basics of materials degradation- thermodynamics and kinetics - Pourbaix diagram, chemical and electrochemical reactions; Degradation types and mechanisms; Degradation of different material systems: Metals, alloys, ceramics and glasses, polymers and composites for versatile applications- structural, functional, energy and biomedical; Impact on materials properties; Investigation for materials degradation; Protection from degradation and materials design; Environmental and biological aspects; Societal impact.

MSE 767. Process Modeling/Simulation. 3 Hours.
Theory and practice of analytical methods and computation modeling for manufacturing processes of metals, ceramics, polymers and composites. Applications on processes such as metal cutting, welding, casting, massive forming, solidification, rapid prototyping, injection molding, and resin transfer molding.

MSE 768. Applied Finite Element Analysis. 3 Hours.
Finite Element Analysis (FEA) is used widely for design optimization and failure prediction in automobile, energy, aerospace, and other industries. This course primarily looks at how practically to set up static structural models and get meaningful results. The focus will be on applying loading and boundary conditions, good meshes, convergence of results, and correct interpretation of results. Students will learn how to set up models using programs such as Pro/Engineer and ANSYS.

MSE 769. Degradation of Materials. 3 Hours.
The course will introduce the thermodynamics and kinetics of materials degradation; degradation mechanisms and types; degradation of different material systems (metals, alloys, ceramics and glasses, polymers and composites) for multifaceted applications; protection from degradation and materials design; Environmental and biological aspects; Societal impact.

MSE 770. Physical Characterization. 3 Hours.
Theory and practice of materials characterization, with emphasis on optical metallography, quantitative metallography, scanning electron microscopy, crystallography, and x-ray diffraction. Specific application in metals and ceramics considered.

MSE 790. Special Topics in (Area). 1-6 Hour.
Special Topics In (Area).

MSE 790L. Special Topics in (Area) Laboratory. 0 Hours.
Special Topics In (Area) Laboratory.

MSE 791. Individual Study in (Area). 1-6 Hour.
Individual Study in (Area).


MSE 799. Dissertation Research. 1-12 Hour.
Prerequisites: GAC Z