Tuskegee University
College of Engineering
Master of Materials Science and Engineering

Thesis Option

Contact Information: Dr. Shaik Jeelani; email: sjeelani@tuskegee.edu; Ph.: +1 (334) 724-4220
Ms. Shakeya Fielder; email: sfielder@tuskegee.edu; Ph.: +1 (334) 727-8802

Degree Offered: Master of Science in Materials Science and Engineering (MMSE)

The Department of Materials Science and Engineering at Tuskegee University produces graduates who can be successful in academia, industry and national laboratories. We have assembled a multidisciplinary group of faculty members with expertise in various aspects of synthesis, processing, modeling and characterization of advanced materials that may be used for military, industrial, agriculture and healthcare applications.

Admission Requirements:
Applicants must have completed the B.S. degree from a department of approved standing and granted by an accredited college or university in any of the following areas to be considered for the Master's degree program in Materials Science and Engineering:

- Engineering
- Biology
- Chemistry
- Physics
- Mathematics

- Student transcript should provide evidence that the application shall be able to pursue the graduate course work. If the transcript show deficiencies, the student may have to take necessary undergraduate courses to meet the prerequisite requirements.
- Applicants must also have a cumulative GPA of 3.0 or better. Demonstration of competency in mathematics, by passing courses up to and including Calculus III, is required. An applicant may be admitted conditionally if he/she has not completed Calculus III. Upon completion of the mathematics requirement, the "conditional admission" will be changed to "full admission".
- The minimum acceptable combined GRE score is 1000 (old) or 300 (new).
- Official Transcript from all colleges/universities attended (International Students must have transcripts translated through World Education Services-WES)
- Completed Application along with the required amount of application fees
- 3 Letters of Recommendation
- Statement of Purpose
- GRE Scores
- Financial Affidavit (International Students- only)
- Test of English as Foreign Language (TOEFL) Scores (International students only).

Graduation Requirements: 30 credits
Core Courses: 12 credits
Elective Courses: 12

Credits Thesis: 6 credits

Admission to Candidacy

Passing of the Final Oral Examination

Advisory Committee:
During the first semester of his/her study in the MSMSE program, the student and his/her Major Professor must recommend to the Head of the Department for approval, the student's Advisory Committee consisting of a Minimum of four members including the Major Professor and the Head of the Department. The Advisory Committee shall also serve as the Examination Committee.

Core Courses (12 credits): Required for All Students in the Master's program

MSEG 0516: Advanced Strength of Materials– 3 credits (MENG 0316 & Calculus III)

MSEG 0518: Advanced Materials Science and Engineering– 3 credits (MENG 0318 & Calculus III)

MSEG 0521: Polymer Science and Engineering– 3 credits

MATH 0561: Applied Mathematics I– 3 credits

Elective Courses (12 credits):

Determined by the MSE Department Head
Elective courses will be those approved by the Head of the MSE Department, from the list attached.

Transfer Credits:
The student's Advisory Committee may recommend transfer credits for up to 9 hours for graduate courses taken by the student at Tuskegee University as part of another graduate program or at any other institution. Transfer credits may be recommended under both core and elective categories.

Admission to Candidacy:
Immediately after completing 15 credit hours of course work including transfer credits, the student must submit to the Dean of the Graduate School, a completed application for the Candidacy for the degree.

Seminars
A student pursuing the Master of Science degree in Materials Science and Engineering must present at least two seminars. The first seminar shall be the presentation of the student's research proposal of the Master's thesis. The second or the final seminar shall be his/her Final Oral Examination for the degree. The student is also required to participate in all seminars arranged by the department.

Thesis
The final draft of the thesis must be filed with the student's Advisory Committee at least 30 days before the date listed in the university calendar for final copies to be submitted during the semester in which the student expects to graduate. The student must present to the Dean of Graduate Programs a "Preliminary Approval Sheet" (PAS) bearing the signature of the Major Professor before the final oral examination may be scheduled and before copies of the thesis/dissertation are distributed to members of the Examining Committee.
After the "Preliminary Approval Sheet" has been signed, it should be submitted to the Dean of Graduate Programs before the final examination is scheduled and before the final draft of the thesis/dissertation is prepared for final approval. Approval of the thesis/dissertation in its final form rests with the Examining Committee.

Transition from Thesis to the Non-Thesis Option:
Based on the performance of the student in research, the Department Head may recommend the student to transition to the non-thesis option. Such student should complete all the requirements of the MMSE non-thesis option.

LIST OF CORE COURSES

MSEG 0516	**ADVANCED STRENGTH OF MATERIALS.** CR. 3. A continuation of the undergraduate course in Strength of Materials (MENG 0316). Emphasis is placed on stress-strain relationships, failure behavior, yield and fracture under combined stresses fracture toughness of cracked members, fatigue crack growth, creep and damping; and on determination of static and dynamic mechanical properties through laboratory experiments. **Prerequisite: MENG 0316 and Calc III**
MSEG 0518	**ADVANCED MATERIALS SCIENCE AND ENGINEERING.** CR. 3. A continuation of the undergraduate course in Materials Science and Engineering (MENG 0318). Emphasis is placed on the properties and processing methods of classic and modern materials. Application, degradation, selection, design consideration, economic, environmental and societal issues of these materials. Use of microscope to verify materials microstructure and defects through laboratory experiments. **Prerequisite: MENG 0318 and Calc III**
MSEG 0521	**POLYMER SCIENCE AND ENGINEERING**. CR. 3. Introduce the concepts of polymer science and engineering; chain structure and configuration; molecular weights and sizes, concentrated solutions and phase separation behavior; the amorphous state; viscoelasticity and rubber elasticity; transitions and relaxations; crystalline state of polymers; morphology of crystalline polymers.
MSEG 0561	**APPLIED MATHEMATICS I.** 1st Semester, Summer on Demand. Lect. 3, 3 credits. Functions of a complex variable with applications to Physics and Engineering; calculus of variations; matrices and systems of linear equations; eigenvalues and eigenvectors; diagonalization. **Prerequisite: Minimum grade of "C" in MATH 0461 or Departmental Approval (see math's curriculum)**
MSEG 0700	**THESIS (Research)** CR. 6.

LIST OF ELECTIVE COURSES

MSEG 0501	**MATERIALS AND SOCIETY.** CR.3**.** Introduce students to how new materials impacted social structure both historically and in the present day, and to the social and cultural forces that shape the development and use of materials and technologies from the past to future. Demonstrate how materials can be manipulated to solve technical and sociocultural problems. Teach creative thinking about how to apply this knowledge through applied projects discussing future materials innovations.
MSEG 0502	**BIOMATERIALS SCIENCE AND ENGINEERING.**CR. 3**.** Introduce principles and applications of natural and synthetic biomaterials for medical applications. Design, synthesis and characterization of biomaterials, analysis, including microscopy, spectroscopy and Mechanical strength analysis. Importance of biocompatibility of materials in terms of immune response, cell interaction, toxicity and sensitivity.
PHYS 0511	**MODERN PHYSICS II.** 2nd Semester. Lect. 3, 3 credits. The basic postulates and introductory methods of quantum mechanics, classical statistical mechanics, and quantum statistical mechanics with applications in Solid State Physics are studied. **Prerequisite: PHYS 0402, 0410**
MENG 0512	**ADVANCED FLUID MECHANICS.** CR. 3**.** Development of rate of strain relationships for viscous compressible and incompressible fluid flow. General equations of motion, laminar and turbulent flow, boundary layer theory. **Prerequisite: MENG 0313**

CHEM 0513	**ADVANCED INORGANIC CHEMISTRY**. 1st or 2nd Semester. Lect. 3, 3 credits. Chemistry of elements other than carbon. Topics emphasize atomic and molecular structure, ionic and covalent bonding theories, symmetry, acid base theories, transition metal compounds and chemistry of selected representative elements. **Prerequisite: CHEM 0401 and CHEM 237.**
CHEM 0524	**POLYMER CHEMISTRY**. 1st or 2nd Semester. Lect. 2; Lab 6, 4 credits. A survey course on polymeric materials. Areas covered are the synthesis and reactions of polymers, thermodynamics and kinetics of polymerization, the physical characterization of polymers and the fabrication, testing and uses of polymers. These topics are integrated into both the lecture and the laboratory. **Prerequisites: CHEM 0321 and 0323; CHEM 0402 and 0404.**
MENG 0527	**FRACTURE MECHANICS.** CR. 3. Basic principles and applications of fracture mechanics by integrating aspects of materials science and solid mechanics. Emphasis is focused on linear elastic and nonlinear elastic-plastic fracture mechanics theories; practical knowledge of fracture toughness evaluation of metals, polymer and ceramic composites; fatigue crack propagation. **Prerequisite: MENG 0416**.
MENG 0550	**ADVANCED THERMODYNAMICS.** CR. 3. A statistical approach to the study of the first and second laws, thermodynamics relations for the pure substance, application to Clausius inequality and availability in steady flow, real gas mixtures, introduction to the third law and chemical equilibrium. **Prerequisite: MENG 0414.**
PHYS 0550	**SOLID STATE ELECTRONICS AND PHYSICS**. 1st Semester. Lect. 3,3 credits. Introduction to Quantum Mechanics, Quantum Statistical Mechanics, Quantization of semiconductor crystal vibrations - Phonons, Thermal Properties, Free Electron Fermi Gas, Electron energy bands, Phonon and electronic thermal conductivities in semiconducting electronic systems, and Superconductivity and its impact on electric devices. **Prerequisites: PHYS 05511/0402 or consent of instructor**
EENG 0560	**ELECTRICAL PROPERTIES OF MATERIALS.** 1st Semester. Lect. 3, Lab 0, 3 credits. Crystal structure; Bravais lattices, energy bands; Metals, Nonmetals, conduction processes, effective mass, scattering mechanisms, continuity equation and junction theory; Field-material interaction, dielectric losses, magnetic.
MATH 0562	**APPLIED MATHEMATICS II.** 2nd Semester, Summer on Demand. Lect. 3, 3 credits. Special functions; partial differential equations; characteristics; solutions of Laplace, Helmholtz, wave and heat equations; boundary conditions and eigenfunctions; Sturm-Liouville problems; Green's function. **Prerequisite: Minimum grade of "C" in MATH 0461 or Departmental Approval.**
EENG 0578	**ELECTRONIC DEVICE DESIGN AND FABRICATION.** 1st Semester. Lect. 3, Lab 0, 3 credits. Monolithic IC technology; Bipolar and MOSFET processes and structures; Layout design, fabrication, applications. **Prerequisite: EENG 0413 or Permission of Instructor**
MSEG 0601	**PHYSICS OF MATERIALS**. CR. 3. To gain an understanding of the nature of materials based on the physical principles on which the properties of materials depend. The basic relationships introduced in undergraduate physics and chemistry courses are extended using the concepts of quantum mechanics to relate the properties of materials to their internal structure and external environment. Optical, electrical, thermal and magnetic properties of metals, semiconductors and insulators will be covered.
MSEG 0603	**POLYMER PHYSICS**. CR. 3. Principles of polymer physics will be taught. Emphasis is placed on classification of polymers, molecular sizes, polymer blends, morphology, time-independent elasticity, linear viscoelasticity and yield, and yield and fracture polymers**.**

MSEG 0604	**MATERIALS PROPERTIES AND CHARACTERIZATION**. CR. 3. A multidisciplinary course offering a practical hands-on experience with various analytical equipment and analysis of advanced composite materials including nanomaterials. Focus on sample preparation, principles and applications of various microscopy, thermal and mechanical methods. Covered topics include AFM, SEM, TEM, EDX, X-ray, TGA, DSC, DMA, TMA, tensile, compression and flexure tests.
MSEG 0611	**MOLECULAR MODELING OF POLYMERS AND NANOCOMPOSITES**. Cr. 3. To introduce students to the fundamentals of molecular modeling and to put that knowledge to use in a class project. Mini- projects and homework sets will be assigned as needed. Mini- projects require computer calculations. Homework sets will be drawn from the text and from literature sources.
MSEG 0612	**NANOSCALE SCIENCE AND ENGINEERING**. CR. 3. This course aims to introduce students to nanoscale materials science and technology. It will cover topics such as nanoscale material synthesis, properties, and applications. It will also emphasize the theory, modeling and simulation approaches used to understand the synthesis mechanisms and morphological changes in nanoscale materials systems, as well as the properties of materials at the nanoscale. The course will have a balanced materials science (main thrust of the course) mechanics, physics and chemistry and technology flavor. **Prerequisites: graduate standing or senior undergraduate**
MSEG 0614	**MATERIALS AND ENVIRONMENT**. Cr.3. The impact of the environment on polymeric, metallic and ceramic materials is examined. Mechanisms of interaction between materials and the environment are considered. The effects of heat, moisture, UV light, ozone, radiation, acid rain and corrosive environments are included in this study of the effect of the environment on materials. The impact of materials on the environment is surveyed. Case studies and the current literature will be utilized throughout.
CHEM 0622	**ADVANCED ORGANIC CHEMISTRY.** 1st or 2nd Semester. Lect. 3, 3 credits. Fundamental principles and theories of organic chemistry at an advanced level. **Prerequisite: CHEM 0321 and CHEM 0402**
MSEG 0622	**KINETICS OF MATERIALS**. CR. 3. Activated rate theory, solid-state diffusion, atomic theory, solid-state diffusion, atomic theory of diffusion kirkendall effect, Darken equations, high diffusivity phenomenon and chemical reaction kinetics, pertinent to transformations.
MSEG 0623	**THEORY OF ELASTICITY**. CR. 3. Stress-Strain relations, strain energy, general methods of elasticity, reciprocal theorems, energy methods and variational principles. The Rayleigh-Ritz and Galerkin methods. Finite difference and relaxation method. Tensor application. **Prerequisites: MENG 0416 and MATH 0461. Graduate Standing.**
MSEG 0624	**POLYMER CHEMISTRY**. CR. 3. A survey course on polymeric materials. Areas covered are the synthesis and reactions of polymers, thermodynamics and kinetics of polymerization, the physical characterization of polymers and the fabrication, testing and uses of polymers. These topics are integrated into both the lecture and the laboratory. **Prerequisites: Organic Chemistry 321 & 323; Physical Chemistry 402 & 404**
MSEG 0625	**THERMODYNAMICS OF MATERIALS SYSTEMS**. CR. 3. The laws of thermodynamics applied to the stability of material phases, crystal imperfections, solubility, oxidation, surface and interface energy, and transformation. Application of the laws of Thermodynamics to Material Systems: chemical reactions, phase equilibria and transformations, oxidation, theoretical phase diagram generation and non-ideal solution theory. **Prerequisite: MSEG 0625**
MSEG 0628	**FINITE ELEMENT METHOD**. Cr. 3. Principles of finite element analysis, variation principles, displacement polynomials and shape functions, element family, application to 2D and 3D continuum problems, application to thermal and fluid flow problems, computer program development. **Prerequisites: Graduate standing and instructor's approval.**

MSEG 0629	**MICROSTRUCTURAL ANALYSIS OF MATERIALS**. Cr. 3. To provide an integrated treatment of the science of microstructural analysis which emphasizes the interaction of the specimen with the electron beam used to probe the microstructure. The three main aspects of microstructural morphology, phase identification, crystallography, and microanalysis of the chemical composition will be covered. Following an introduction, the principal methods of characterization, e.g., diffraction analysis, scanning and transmission electron microscopy, and chemical microanalytical techniques will be taught. Some laboratory assignments will also be incorporated in this course. **Prerequisite: MSEC 0604**
MSEG 0640	**NON-DESTRUCTIVE EVALUATION TECHNIQUES**. Cr. 3. Basics of NDE of metals and advanced materials, ultrasonics, modal analysis, acoustic emission, acousto-ultrasonics, acoustic impact testing, X-ray radiography. Eddy-current testing, and laser measurements.
MSEG 0641	**COMPOSITE MATERIALS**. CR. 3. Introduction to composite materials; fibers, matrix and interface; mechanical and chemical aspects; design, chemical synthesis, manufacturing and processing methods; mechanical testing methods; understanding of failure mechanisms based on static, fatigue, impact and other properties; microstructural consideration. **Prerequisite: MENG 0318**
MSEG 0642	**MECHANICS OF COMPOSITES**. CR. 3. Classification and characterization of composite materials; mechanical behavior of composite materials; stress-strain relation for anisotropic materials; invariant properties of an orthotropic lamina; strength concepts and biaxial strength theories; classical lamination theory and theory of an anisotropic elastic continuum; equations of laminated anisotropic plates. **Prerequisite: MSEG 0641**
MSEG 0690	**SPECIAL TOPICS**. Cr. 3. Advanced topics in materials science and engineering **(prerequisite: Graduate standing and approval of major professor and instructor).**
MSEG 0701	**CONTINUOUS REGISTRATION**. Cr. 0.
MSEG 0702	**CANDIDATE FOR DEGREE**. Cr. 0.

Additional details that are not shown in this document may be found on the website of the Department of Materials Science and Engineering and in the TU's Graduate Handbook.