**Course number and name: MTSE 3000: Fundamentals of Materials Science and Engineering I**

**Credits and contact hours:** 3 Credits. Walk in or by appointment

**Instructor’s or course coordinator’s name**: Dr. Marcus L. Young

**Text book, title, author, and year**

Fundamentals of Materials Science and Engineering, An Integrated Approach, by: William D. Callister & David G. Rethwisch, 3rd Edition, John Wiley, 2008, 4th Edition, John Wiley, 2011, or 5th Edition, John Wiley, 2015.

1. *Other supplemental materials*

Electronic copies of lectures on Blackboard.

**Specific Course Information**

1. *Brief description of the content of the course (catalog description)*

Principles of bonding, structure, and structure/property relationships for metals and their alloys, ceramics, polymers and composites. Emphasis on properties and how processes change structure and, consequently, properties.

1. *Prerequisites or co-requisites*

PHYS 1710. CHEM 1410/CHEM 1430 (for MTSE Undergraduates) or CHEM 1415/CHEM 1435.

1. *Indicate whether a required, elective, or selected elective course in the program*

Required

**Specific goals for the course**

1. *Specific outcomes of instruction*

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| **Specific Course Learning Outcome** |  |  |  |  |  |  |  |  |
| 1. Demonstrate ability to relate bond   energy to properties of engineering materials |  |  |  |  |  |  |  |  |
| 1. Interpret various crystal structures   using Miller Indices for planes and directions |  |  |  |  |  |  |  |  |
| 1. Determine contributions of   various strengthening mechanisms, including solid solution strengthening, precipitation strengthening, strain hardening, and grain size strengthening (the Hall-Petch relationship) |  |  |  |  |  |  |  |  |
| 1. Demonstrate ability to read a   phase diagram, including determining phase diagram type, predict phase compositions (given C0 and T), and predict microstructures for given compositions. |  |  |  |  |  |  |  |  |
| 1. Interpret mechanical properties,   including yield strength, ultimate tensile strength, and elastic modulus from engineering plots of σ-ε |  |  |  |  |  |  |  |  |
| 1. Exhibit awareness of societal implications associated with a material, including globally, economically, and environmentally, as well as occupational safety |  |  |  |  |  |  |  |  |
| 1. Conduct and present a material   selection survey as part of a team for current materials applications. |  |  |  |  |  |  |  |  |

1. *Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*

This course addresses ABET Student Outcomes 1,3,4,5 and 7

**Brief list of topics to be covered**

I. Electronic and Atomic Structure and Bonding

Atomic Structure

Bonding Types and correlations with properties

II. Material Building Blocks

Crystalline Structures (Metals and Ceramics)

Miller Indices

Single Crystals

Polycrystalline materials

Non-crystalline materials

Polymeric Structures

Defects

III. On Microstructure-Property Relationships

Mechanical Properties

Deformation and Strengthening Mechanisms

IV. On Microstructural Evolution

Phase Diagrams

Diffusion

Phase Transformations

V. Materials in Application

Failure and Corrosion

Material Applications and Processing

Team Presentations on Material Applications

VI. Other Considerations (environment, health, availability, design)

Electrical, Thermal, Magnetic and Optical Properties

Characterization