**Course number and name: MTSE 3020: Microstructure and Characterization of Materials**

**Credits and contact hours:** 3 Credits. Tuesday (10:30-11:30am). Other times available on request via e-mail.

**Instructor’s or course coordinator’s name**: Dr. Mohamed El Bouanani

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

The Instructor will supply handouts and references.

Course notes for each class (PPT files) will be e-mailed to students

1. *Other supplemental materials*

* Materials Characterization, Y. Leng, Wiley (2010) ISBN 978-0470822982
* Microstructural Characterization of Materials, David Brandon and Wayne Kaplan, 2nd Edition, (2008), ISBN-13 978-0470027851, Wiley
* “Elements of X-Ray Diffraction”, B.D. Cullity and S.R. Stock, (2001) ISBN-13 978-0201610918
* Scanning Electron Microscopy and X-Ray Microanalysis, 3rd Ed., Goldstein, Newbury, Joy, Lyman, Echlin, Lifshin, Sawyer and Michael, (2003), 978-0306472923

**Specific Course Information**

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

Introduction to dislocations, grain boundaries, surfaces and multiphase microstructures. Optical and electron microscopic characterization of microstructures.

1. *Prerequisites or co-requisites*

MTSE 3000, 3001

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

Required

**Specific goals for the course**

*a. Specific outcomes of instruction*

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| **Specific Course Learning Outcome** |
| 1. Understand the types of data that may be obtained when using the four primary techniques discussed in class, specifically: optical microscopy, electron microscopy, x-ray diffraction, and spectroscopic techniques. |
| 2. Ability to manipulate the data and obtain quantifiable metrics to describe aspects of the material, including volume fraction and size of phases, lattice parameter, and composition |
| 3. Understand the applicability of the four techniques, as well as their limitations, in quantifying microstructural features. |
| 4. Knowledge of the role of composition and microstructure – *as determined using these techniques*. |

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

This course addresses ABET Student Outcome 7

**Brief list of topics to be covered**

Syllabus overview/General Introduction to Characterization

Review of elements of structure (bonding, defects, phases, compositions)

I. Topics on Optical microscopy

Metallographic Preparation Techniques

Resolution (Rayleigh criterion, pixel counts)

Contrast Formation

Digital Imaging

Image Quantification – Stereology

*Examples of optical microscopy in applications*

II. Topics on Electron microscopy

Basics of electron sources and vacuum

Signal types (SE, BSE)

Energy Dispersive Spectroscopy (EDS)

How TEM fundamentally differs

*Examples of electron microscopy in applications*

III. Topics on X-ray diffraction

Bragg’s Law

Structure Factor

Powder diffraction

Textured diffraction

*Examples of X-Ray diffraction in applications*

IV. Topics on Other Spectroscopies

Using photon and ion probes

X-Ray Fluorescence

X-Ray Photoelectron spectroscopy

Ion interactions with matter

Rutherford Backscattering Spectroscopy

Secondary Ion Mass Spectroscopy

*Examples of various spectroscopies in applications*