UNIT INFORMATION

Program	Mechanical Sciences (53001010053P0)
Course unit	MICROSTRUCTURAL AND MECHANICAL CHARACTERIZATION TECHNIQUES
Unit code	PCMEC
Unit number	1978
Credit points	4
Period	
Professor	Alysson Martins Almeida Silva
Prerequisites	No

UNIT OUTLINE

Objective:

Provide students with the theoretical and practical fundamentals of the main material characterization techniques, focusing on their applications in structural, chemical, thermal, and morphological analysis of different material classes.

Purpose:

Contents:

1. Introduction to Material Characterization
- Importance of characterization in materials science
- Classification of analytical techniques: structural, chemical, thermal, and morphological
- Interpretation of results and correlation between techniques

2. Structural Characterization Techniques
- **X-ray Diffraction (XRD)**
  - Fundamentals of X-ray diffraction
  - Methods for identifying crystalline phases (Rietveld method)
  - Applications in ceramics, metals, and polymers
- **Small-Angle X-ray Scattering (SAXS)**
  - Principles and applications in the analysis of nanostructured materials

3. Spectroscopic Techniques for Chemical Bond Identification
- **Fourier Transform Infrared Spectroscopy (FTIR)**
  - Fundamentals and vibrational modes
  - Sampling techniques: ATR, transmission, and reflection
- **X-ray Photoelectron Spectroscopy (XPS)**
  - Principles and applications in surface chemical composition analysis

4. Thermal Techniques for Studying Stability and Physicochemical Transformations
- **Thermal Analysis (TGA, DSC, DTA)**
  - **Thermogravimetric Analysis (TGA):** thermal degradation and stability
  - **Differential Scanning Calorimetry (DSC):** phase transitions

5. Morphological and Microstructural Characterization Techniques
- **Scanning Electron Microscopy (SEM)**
  - Image formation and contrast
  - Operating modes (SE, BSE, EDS)
- **X-ray Microtomography**

- Principles and applications in the three-dimensional reconstruction of materials

6. Adsorption Techniques and Optical Spectroscopy

- **Gas Adsorption (BET)**
  - Determination of surface area and pore size
- **UV-Vis Spectroscopy**
  - Fundamentals and applications in the analysis of optically active materials

7. Laboratory Practices (20 hours)

- Sample preparation for characterization
- Experimental analysis with XRD, FTIR, SEM, TGA/DSC, XPS, BET, and UV-Vis
- Interpretation and discussion of results
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Assessment:

Obs.:

References:

1. Cullity, B. D., & Stock, S. R. (2014). Elements of X-ray Diffraction. Pearson.
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis. Cengage Learning.
3. Rouessac, F., & Rouessac, A. (2013). Chemical Analysis: Modern Instrumentation Methods and Techniques. Wiley.
4. Fultz, B., & Howe, J. M. (2012). Transmission Electron Microscopy and Diffractometry of Materials. Springer.