



PHD PROGRAM IN APPLIED ENGINEERING

COMPULSORY TRAINING OF THE PHD PROGRAM

Course Title	SEM (Scanning Electron Microscope)
Duration	1 ETCS (25 h)
Type of activity	Tutoring: 17 h Practicals and student's personal work: 8 h
Contents	<ul style="list-style-type: none">- Introduction (0.5 h)- Scanning Electron Microscopy (24.5 h)- Theory (17 h) (demonstrations on FE-SEM: 7.5 h)<ul style="list-style-type: none">1.1. Introduction (0.5 h) (equipment 0.25 h)1.2. Physics of electron-matter interactions (4 h)1.3. Electron optics (3.75 h) (equipment 0.25 h)1.4. Image formation and interpretation (2.75 h) (equipment 1 h)1.5. Operating modes and detectors (FE-SEM Nova NanoSEM 450) (3.5 h) (equipment 4.33 h)1.6. X-ray microanalysis. Qualitative analysis (1.25 h) (equipment 0.75 h)1.7. EBSD analysis. Basic concepts (1.25 h) (equipment 0.92 h)
Bibliography	<ul style="list-style-type: none">- Goldstein, J. et al. Scanning Electron Microscopy and X-Ray Microanalysis.- Ul-Hamid, A. A Beginners' Guide to Scanning Electron Microscopy.- Egerton, R. Introduction to Scanning Electron Microscopy.- Reimer, L. Scanning Electron Microscopy: Physics of Image Formation and Microanalysis.- Bozzola, J.J. & Russell, L.D. Electron Microscopy: Principles and Techniques for Biologists.
Learning outcomes	<ul style="list-style-type: none">- Understand the theoretical foundations of the material characterization technique "Scanning Electron Microscopy," both from the perspective of microscopic observations and microanalysis by X-rays and electron backscatter diffraction (EBSD).- Understand the operation and gain initial hands-on experience with a scanning electron microscope.
Assessment	Assessment will be on a Pass/Fail basis
Timing within the PhD program	Between the 1st and 3rd year of the thesis