

<b>SUBJECT:</b> Techniques of Microscopy		
<b>COORDINATOR:</b> Francisco Javier González Benito		
<b>POSTGRADE:</b> MASTER IN Materials Science and Engineering	<b>ECTS:</b> 6	<b>TERM:</b> 2
<b>Teachers:</b> Carmen Ballesteros, Beatriz Galiana Blanco, Dania Olmos Díaz, Alejandro Várez Álvarez, Fco. Javier González Benito		

SCHEDULE OF THE SUBJECT									
WEEK	SESION	DESCRIPTION OF THE SESION CONTENT	GROUP		Indicate necessary space (informatics room, laboratory, etc.	WORK OF THE STUDENT DURING THE WEEK			TEACHER
			1	2		DESCRIPTION	CLASSROOM HOURS	WORKING HOURS Week maximum 7 H	
1	1	Introduction to microscopy as materials characterization techniques	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	4	Fco. Javier González Benito
2	2	Optical microscopy	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	4	Fco. Javier González Benito
2	3	Confocal microscopy	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	4	Fco. Javier González Benito
3	4	Practical cases about Confocal microscopy	x		Classroom (4.2E02)	Preparation of collaborative work about a research article (in groups) and oral presentation	1,5	6	Fco. Javier González Benito

3	5	Introduction to the electronic optics. Description of Transmission electron microscope	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1.5	5	Carmen Ballesteros
4	6	Image formation in a Transmission electron microscope	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Carmen Ballesteros
4	7	Cinematic and dynamic theory of contrast. Defects contrast in crystalline structures	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1.5	5	Carmen Ballesteros
5	8	Introduction to the electronic microscopy of high resolution. Image calculus	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Carmen Ballesteros
5	9	Introduction to the scanning transmission electron microscopy STEM	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Carmen Ballesteros
6	10	EELS and images with contrast in atomic number	x		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Carmen Ballesteros

6	11	Introduction to the scanning electron microscopy. Description of the scanning electron microscope. detectors	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Alejandro Várez
7	12	Scanning Tunneling Microscopy, STM	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Agustina Asenjo
7	13	Image formation in SEM. Other methods of contrast	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Alejandro Várez
8	14	Atomic Force Microscopy (AFM). Main operation modes and instrumentation	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Dania Olmos
9	15	Practical issues of the AFM	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	4	Dania Olmos
10	16	Introduction to X-Ray microanalysis. X-Ray generation and measurement (detectors)	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Alejandro Várez

		geometric aspects.							
11	18	Qualitative analysis. Spectral artefacts. Quantitative analysis. Methods of correction	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Alejandro Várez
10	17	Electric and Magnetic Field Microscopies	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	5	Dania Olmos
11	19	Infrared, Raman and Fluorescence microscopies	X		Classroom (4.2E02)	Study of recommended bibliography, read slides and do exercises	1,5	4	Fco. Javier González Benito
12	20	TEM (I)	x		LABMET	Preparation of results report related to the practical cases	1,5	6	Beatriz Galiana
12	21	SEM (I)	X		Laboratory of scanning electron microscopy	Preparation of results report related to the practical cases		5	Alejandro Várez
13	22	AFM (I)	X		Laboratory of Atomic Force Microscopy	Preparation of results report related to the practical cases	1,5	5	Dania Olmos

13	23	TEM (II)	X		LABMET	Preparation of results report related to the practical cases		6	Beatriz Galiana
14	24	SEM (II)	X		Laboratory of scanning electron microscopy	Preparation of results report related to the practical cases		5	Alejandro Várez
14	25	AFM (II)	X		Laboratory of Atomic Force Microscopy	Preparation of results report related to the practical cases	1,5	5	Dania Olmos
14	26	TEM (III)	X		LABMET	Preparation of results report related to the practical cases		6	Beatriz Galiana
15	27	SEM (III)	X		Laboratory of scanning electron microscopy	Preparation of results report related to the practical cases		5	Alejandro Várez
15	28	AFM (III) - Grupo 1	X		Laboratory of Atomic Force Microscopy	Preparation of results report related to the practical cases	1,5	5	Dania Olmos
<b>TOTAL HORAS</b>							42	138	

**Practical cases**

Confocal	Work preparation and group presentation on a recent research about the use of confocal microscopy to study materials
TEM (I)	Practical Cases of TEM (I): Observation of deformed samples: Contrast of dislocations and defects. Structural analysis (Diagram of electron diffraction, X-ray fluorescence spectrum).
TEM (II)	Practical Cases of TEM (II): High Resolution Electron Microscopy (Obtaining and image analysis). Diffraction diagram simulation. Images with Z contrast.
SEM (I)	Practical Cases of SEM (I): Obtaining images at high vacuum. Basic alignment operations, brightness contrast. Handling of different detectors.
SEM (II)	Practical Cases of SEM (II): Obtaining images of insulating samples. Obtaining images at low vacuum.
SEM (III)	Practical Cases of SEM (III): Obtaining a X-Ray spectrum. Geometric aspects. Detection of spectral artifacts.
AFM (I)	Practical Cases of AFM (I): Introduction to AFM contact and tapping modes
AFM (II)	Practical Cases of AFM (II): AFM with temperature control
AFM (III)	Practical Cases of AFM (III): Mechanical characterization by using an AFM