ECTS catalog with learning outcomes
University of Montenegro

Faculty of Metalurgy and Technology / /

Course:				
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
12234	Mandatory	1	6	3+1+1

Programs	
Prerequisites	No prerequisites
Aims	This course aims to introduce students to the basics of crystallography and lattice, studying a certain number of typical crystal structures, implementing methods of determining the structure of crystalline materials, applying these methods in metal science to determine the structure, measurement of particle size, and determination of crystal orientation.
Learning outcomes	After successfully considering and learning the theory of X-ray diffraction, students will be introduced to the experimental methods of applying X-ray diffraction in determining the orientation of single crystal structure, the structure of polycrystalline aggregates, crystal structure, measuring lattice parameters, as well as determining residual stresses and solving many other essential case studies. Based on the presentation of computational and experimental methods of examining the structure of metal materials and their appropriate selection, as well as a comparative analysis of their applicability, they can recognize the possibility of implementing specific methods of structural analysis. Students acquired the knowledge necessary for fully defining the structure for quality control and designing materials with improved or particular properties.
Lecturer / Teaching assistant	prof. dr Nada Jauković
Methodology	Lectures, exercises, homework assignments, consultation.
Plan and program of work	
Preparing week	Preparation and registration of the semester
I week lectures	Introduction to the geometry of crystals. Lattices. Crystal systems. Indices of planes and directions. Scalar product.
I week exercises	Crystallography I (examples and assignments).
II week lectures	Typical crystal structures. Solid solutions. Interstitial and substitutional solid solutions. Ordered structures. Examples of typical structures.
II week exercises	Crystallography II (examples and assignments).
III week lectures	Elements of symmetry of the crystal. Space and point groups. Relation of macroscopic and microscopic aspects of symmetry with physical and mechanical properties.
III week exercises	Density and the atomic packaging factor of a face-centred cubic lattice, primitive cubic lattice and close-packed hexagonal lattices.
IV week lectures	Reciprocal lattice. The application of vectors, vector product, triple scalar product, nomenclature, and real and reciprocal space.
IV week exercises	Crystallography III. The crystallography of slip.
V week lectures	Using a reciprocal lattice. Directions, planes, zones. Reciprocal lattices of heterophase systems. Crystallographic interdependence of heterophase structures.
V week exercises	Midterm exam 1.
VI week lectures	Diffraction methods. X-ray diffraction and electron diffraction. Application in crystallography.
VI week exercises	Make-up midterm exam 1.
VII week lectures	Ewald sphere. Determination of unknown crystal structure. Quantitative analysis of multiphase systems.
VII week exercises	Absorption of X-rays. Indexing of radiographs. Examples and assignments.
VIII week lectures	Transmission electron microscopy (TEM). Microdiffraction. Kinematic and dynamic theory of diffraction.
VIII week exercises	Qualitative and quantitative X-ray structural analysis. Examples and assignments.
IX week lectures	Spherical projection. Introduction to stereographic projection. Elements of stereographic projection.
IX week exercises	Stereographic projection I (examples and assignments).
X week lectures	Standard stereographic projections of typical crystal structures.

X week exercises	Stereographic projection II (examples and assignments).
XI week lectures	Textures. Methods of direct determination of textures. Inverse pole figures. Stereographic projection.
XI week exercises	Midterm exam 2.
XII week lectures	Defects in crystals. Comparison of defect energies in metals.
XII week exercises	Examples and assignments.
XIII week lectures	Dislocations. Point defect-dislocation interactions. Surface boundaries. Models.
XIII week exercises	Examples and assignments.
XIV week lectures	Preparation for final exam.
XIV week exercises	Make-up midterm exam 2. Submission of homework.
XV week lectures	Preparation for final exam.
XV week exercises	Solving the selected problems.
Student workload	Per week: 6 credits x 40/30 hours = 8 hours Total workload for the course: 6 x 30 = 180 hours

Per week	**Per semester**
6 credits x 40/30=8 hours and 0 minuts 3 sat(a) theoretical classes 1 sat(a) practical classes 1 excercises **3 hour(s) i 0 minuts** of independent work, including consultations	Classes and final exam: **8 hour(s) i 0 minuts x 16 =128 hour(s) i 0 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **8 hour(s) i 0 minuts x 2 =16 hour(s) i 0 minuts** Total workload for the subject: **6 x 30=180 hour(s)** Additional work for exam preparation in the preparing exam period, including taking the remedial exam from 0 to 30 hours (remaining time from the first two items to the total load for the item) **36 hour(s) i 0 minuts** Workload structure: **128 hour(s) i 0 minuts (cources), 16 hour(s) i 0 minuts (preparation), 36 hour(s) i 0 minuts (additional work)**
Student obligations	Students are required to attend classes, do their homework and take the midterm exams.
Consultations	Tuesday and Thursday, 10:00 - 12:00.
Literature	V.R. Radmilović, N.V. Jauković, Lectures. B.D. Callity, S. R. Stock, Elements of X-ray diffractions, Pearson, 2001. W.D. Callister, Fundamentals of materials science and engineering: An Integrated Approach, Wiley, 2018.
Examination methods	Homework- total 10 (1 point per homework, total 10 points); Two midterm exams (20 points each, total 40 points); Final exam (50 points); Passing grade is obtained if at least 50 points are collected.
Special remarks	-
Comment	-

Grade:	F	E	D	C	B	A
Number of points	less than 50 points	greater than or equal to 50 points and less than 60 points	greater than or equal to 60 points and less than 70 points	greater than or equal to 70 points and less than 80 points	greater than or equal to 80 points and less than 90 points	greater than or equal to 90 points