Faculty of Metalurgy and Technology / METALLURGY AND / PHYSICAL METALLURGY-BASICS OF STRENGHT&PLASTICITY

Course:	PHYSICAL METALLURGY-BASICS OF STRENGHT&PLASTICITY			
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
1480	Mandatory	4	7	3+2+0
Programs	METALLURGY AND			
Prerequisites	No prerequisites			
Aims	This course aims to introduce the changes in the structure of metal materials during thermomechanical processing. Enabling students to explain the influence of microstructures on mechanical properties, that is, on the behaviour of deformed and deformed and annealed metal materials. Introduction to the basic characteristics of fracture of metallic materials, fatigue of metallic materials and creep.			
Learning outcomes	After successful completion of this course, the student will be able to explain changes in structure during thermomechanical processing and analyze the influence of structure on mechanical properties, which is the basis for understanding the interdependence of composition, thermomechanical processing, structure and mechanical properties of metal materials; understands the mechanisms that, as a result of the action of an external force, lead to changes in the structure and determine the final properties of the material; acquiring knowledge about the physical basis of fracture occurrence in materials, fracture mechanisms and static deformation at elevated temperatures, solves problems encountered in practice in the field of physical metallurgy.			
Lecturer / Teaching assistant	Prof. dr Vanja Asanović			
Methodology	Lectures, exercises. Homework assignments. Quizzes. Essay. Consultation.			
Plan and program of work				
Preparing week	Preparation and registration of the semester			
I week lectures	Introduction. Crystal defects. Vacancies.			
I week exercises	Vacancy movement mechanisms, sources and sinks of vacancies, interstitial defects. Exercises. Homework 1.			
II week lectures	Dislocations and slips. Crystal plasticity. Geometry of dislocations and movement of dislocations.			
II week exercises	Basic characteristics and mechanisms of plastic deformation. Exercises. Homework 2.			
III week lectures	Elastic properties of dislocations. Multiplication and mobility of dislocations. Reactions of dislocations.			
III week exercises	Dislocations. Exercises and case studies. Homework 3.			
IV week lectures	Twins and twinning. Surface boundaries.			
IV week exercises	Slip and twinning, grain boundaries and subgrain boundaries. Case studies. Quiz 1: Dislocations and slip. Homework 4.			
V week lectures	Work hardening. Dislocation mechanism. Dislocation substructure.			
V week exercises	Strengthening mechanisms. Exercises. Case studies. Quiz 2: Twins and twinning. Surface boundaries. Homework 5.			
VI week lectures	Deformation and strengthening of polycrystalline materials.			
VI week exercises	Midterm exam 1. Plastic yielding criteria. Exercises and case studies. Homework 6.			
VII week lectures	Solid solution strengthening. Reactions of dislocations with dissolved atoms. Dislocation substructure.			
VII week exercises	Solid solution strengthening. Exercises and case studies. Homework 7.			
VIII week lectures	Precipitation hardening and dispersion strengthening.			
VIII week exercises	Make-up Midterm exam 1. Submission of homework 1 - 5.			
IX week lectures	The behaviour of deformed metal during heating. Recovery.			
IX week exercises	Precipitation strengthening. Case studies. Homework 8. Consideration of essay topics.			
X week lectures	Recrystallization. Grain growth.			
X week exercises	Recrystallization. Exercises. Quiz 3: Deformation and strengthening. Homework 9.			
XI week lectures	Texture. Effect of texture on properties.			

XI week exercises	Midterm exam 2. Quiz 4: Behavior of deformed metal during heating.
XII week lectures	Fracture. Dislocation mechanism of brittle fracture. Macroscopic and microscopic properties of brittle and ductile fracture.
XII week exercises	Texture. Examples. Homework 10.
XIII week lectures	Material fatigue.
XIII week exercises	Make-up midterm exam 2. Quiz 5: Fracture and fatigue of materials.
XIV week lectures	Creep.
XIV week exercises	Essay presentation. Submission of homework 6-10.
XV week lectures	Preparation for the final exam.
XV week exercises	Solving the selected problems.
Student workload	Per week: 7 credits x 40/30 hours = 9 hours and 20 minutes Total workload for the course: 7 x 30 = 210 hours

Per week	**Per semester**
7 credits x 40/30=9 hours and 20 minuts 3 sat(a) theoretical classes 0 sat(a) practical classes 2 excercises **4 hour(s) i 20 minuts** of independent work, including consultations	Classes and final exam: **9 hour(s) i 20 minuts x 16 =149 hour(s) i 20 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **9 hour(s) i 20 minuts x 2 =18 hour(s) i 40 minuts** Total workload for the subject: **7 x 30=210 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) **42 hour(s) i 0 minuts** Workload structure: **149 hour(s) i 20 minuts (cources), 18 hour(s) i 40 minuts (preparation), 42 hour(s) i 0 minuts (additional work)**
Student obligations	Students are required to attend classes, do their homework, submit essay and take the midterm exams.
Consultations	Monday and Wednesday, 10:00 - 12:00.
Literature	Đ. Drobnjak, Fizička metalurgija, Fizika čvrstoće i plastičnosti I, TMF, Beograd, 1990. R. E. Smallman, A. H. W. Ngan, Modern Physical Metallurgy, Butterworth-Heinemann, Oxford, 2014. B. Perović, Fizička metalurgija, MTF, Podgorica, 1997.
Examination methods	Homework- total 10 (1 point per homework, total 10 points); Essay (5 points); Quizzes - total 5 (1 point per quiz, total 5 points); Two Midterm exams (15 points each, total 30 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