Solidification, Casting and Welding

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	MSEN 811	**SEMESTER**	8th Semester
COURSE TITLE	**Solidification, Casting and Welding**		
TEACHING ACTIVITIES Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
		4 (3L + 1Lab/Demo)	6
COURSE TYPE	Scientific area / Skill development		
PREREQUISITES	Thermodynamics; Introduction to Materials Science and Engineering; Phase diagrams basics.		
TEACHING AND EXAMINATION METHODS	Lectures with demonstrations; problem-solving; lab-style assignments on defects and microstructure; final written exam.		
COURSE OFFERED TO ERASMUS STUDENTS	Yes (taught in English, subject to minimum enrollment).		
COURSE URL	https://elearning.auth.gr/course/view.php?id=xxxxx		

2. LEARNING OUTCOMES	
Learning Outcomes	• Relate solidification conditions to microstructure evolution (grain structure, segregation, dendrites). • Explain casting process families and select suitable routes based on geometry, alloy, and quality requirements. • Identify common casting defects and propose preventive and corrective actions. • Describe the fundamentals of welding processes and heat-affected zones and link them to microstructure and properties. • Assess residual stresses, distortion, and cracking risks in cast/welded components. • Apply basic process-selection and quality-control reasoning for industrial components.
General Skills	• Process understanding linked to microstructure and performance • Problem solving using simplified heat-transfer and solidification concepts • Quality mindset: defects, inspection, and standards awareness

	• Technical reporting based on case studies

3. COURSE CONTENT
• Solidification fundamentals: nucleation, growth, thermal gradients, cooling rates. • Segregation and constitutional supercooling; dendritic structures; grain refinement. • Casting processes: sand, investment, die casting, continuous casting; gating and risering concepts. • Solidification defects: porosity, shrinkage, hot tearing; defect prevention strategies. • Microstructure control through alloying, inoculation, and heat treatment (overview). • Welding fundamentals: energy sources and key processes (arc, resistance, laser) (overview). • Weld metallurgy: fusion zone and heat-affected zone; solidification cracking and transformations. • Residual stresses, distortion, and welding defects; inspection and quality assurance overview. • Case studies linking processing to component failure and reliability.

4. LEARNING & TEACHING METHODS - EVALUATION	
Teaching method	Face-to-face. Lectures, demonstrations, guided problem sessions, and case-study-based assignments.
Use of ICT	E-learning for notes; video demonstrations; basic process simulation/visualization datasets (where available); spreadsheets for simplified solidification calculations.
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

Activity	Workload/semester (hours)
Lectures	39
Laboratory demonstrations / tutorials	13
Case-study assignment / report	16
Independent study	64
Exam preparation	16
Final written exam	2
Total	**150**

Student evaluation	Assessment language: English. Methods: written final exam (60%), case-study assignment/report (25%), quizzes/problem sets (15%). Students are informed via the course guide and e-learning announcements.

5. SUGGESTED BIBLIOGRAPHY
EUDOXUS
To be specified in EUDOXUS.
Additional bibliography for study
• J. Campbell, Complete Casting Handbook.

- D.A. Porter, K.E. Easterling & M.Y. Sherif, Phase Transformations in Metals and Alloys (solidification sections).
- S. Kou, Welding Metallurgy.
- Selected course notes (indicative): MIT Materials Processing / Cambridge materials processing teaching materials.