Thermodynamics

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 304	**SEMESTER**	3rd Semester
COURSE TITLE	**Thermodynamics**		
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 + 1T)	6
COURSE TYPE	Scientific area / Skill development		
PREREQUISITES	General Chemistry; Calculus I–II; Introductory Physics. Recommended: Data Analysis/Statistics.		
TEACHING AND EXAMINATION METHODS	Face-to-face lectures and problem-solving tutorials. Continuous assessment via problem sets; final written examination.		
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	• Apply the laws of thermodynamics and thermodynamic potentials to materials problems. • Use chemical potential and Gibbs free energy to analyze phase equilibria and phase diagrams. • Model ideal and non-ideal solutions using activities and mixing rules. • Analyze driving forces for phase transformations and chemical reactions in materials processing. • Perform basic calculations for multi-phase equilibrium using graphical and computational approaches. • Critically interpret thermodynamic data and assess assumptions/uncertainties.
General Skills	• Quantitative modeling and problem solving • Use of data and computational tools for engineering decisions • Independent learning from advanced references • Clear technical communication of assumptions and results

3. COURSE CONTENT

- Thermodynamic variables, state functions, and the 1st and 2nd laws.
- Entropy, enthalpy, Helmholtz and Gibbs free energies; Maxwell relations.
- Chemical potential; phase equilibrium; phase rule; Clapeyron and Clausius–Clapeyron.
- Solution thermodynamics: ideal solutions, regular solutions, activities, partial molar quantities.
- Binary phase diagrams and common reactions (eutectic, peritectic, miscibility gaps).
- Thermodynamics of phase transformations and nucleation (driving force concepts).
- Thermochemistry and chemical reactions in materials (Ellingham-type analyses where relevant).
- Intro to statistical thermodynamics concepts relevant to materials.
- Introduction to computational thermodynamics (CALPHAD concept) and use of databases (overview / demos).

4. LEARNING & TEACHING METHODS - EVALUATION

Teaching method	Face-to-face. Lectures combined with tutorial-based problem solving and guided computational demonstrations.
Use of ICT	E-learning for notes/problem sets; spreadsheets/Python for equilibrium calculations; demonstrations of thermodynamic databases/software (where available).
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

Activity	Workload/semester (hours)
Lectures	39
Tutorials / problem sessions	13
Problem sets	20
Independent study	60
Exam preparation	16
Final written exam	2
Total	**150**

Student evaluation	Assessment language: English. Methods: written final exam (60%), graded problem sets (30%), short quiz or midterm test (10%). Students are informed via the course guide and e-learning announcements.

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

To be specified in EUDOXUS.

Additional bibliography for study

- D.R. Gaskell, Introduction to the Thermodynamics of Materials.
- D.A. Porter, K.E. Easterling & M.Y. Sherif, Phase Transformations in Metals and Alloys (thermo sections).
- C. Kittel & H. Kroemer, Thermal Physics (selected chapters).
- Selected open courseware notes (indicative): MIT OCW Thermodynamics of Materials.