ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

Powder metallurgy

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 712	**SEMESTER**	7th Semester
COURSE TITLE	**Powder metallurgy**		
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	Introduction to Materials Science and Engineering; Thermodynamics recommended.		
TEACHING AND EXAMINATION METHODS	Lectures and tutorials; analysis of powder characterization data; final written exam and a short technical report.		
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	• Explain powder production routes and relate powder characteristics to processability. • Select and apply powder characterization methods (particle size, morphology, flowability, density). • Analyze compaction and shaping mechanisms and their influence on green density and defects. • Describe sintering mechanisms (solid-state and liquid-phase) and predict densification trends. • Assess full-density consolidation routes (HIP, forging of PM preforms) and links to AM feedstocks. • Choose powder metallurgy routes for specific components considering performance, cost, and sustainability.
General Skills	• Experimental data interpretation and reporting • Quantitative reasoning on process parameters • Awareness of industrial constraints and quality assurance • Independent learning from standards and technical literature

3. COURSE CONTENT

- Introduction to powder metallurgy and applications (structural parts, filters, magnetic materials, hardmetals).
- Powder production methods: atomization, reduction, electrolysis, mechanical milling; powder recycling.
- Powder characterization: size/shape distributions, surface area, flow, apparent and tap density.
- Compaction and shaping: uniaxial pressing, CIP, powder injection molding; binders and lubricants.
- Sintering fundamentals: diffusion mechanisms, neck growth, densification, grain growth; liquid-phase sintering.
- Post-processing: sizing, heat treatment, infiltration, surface treatments.
- Full-density processes: HIP, hot pressing, forging/rolling of PM preforms; links to AM (powder bed).
- Defects, quality assurance, and standards; safety aspects (dust, handling).
- Design for powder metallurgy and case studies.

4. LEARNING & TEACHING METHODS - EVALUATION

Teaching method	Face-to-face. Lectures and tutorials supported by data-analysis exercises and case studies; optional lab demonstrations.
Use of ICT	E-learning for notes; spreadsheets for particle size and densification calculations; optional image analysis software for powder morphology (demo).
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
Data analysis / short report	16
Independent study	64
Exam preparation	16
Final written exam	2
Total	**150**

Student evaluation	Assessment language: English. Methods: written final exam (60%), technical report/data-analysis assignment (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

- R.M. German, Powder Metallurgy and Particulate Materials Processing.
- A. Lawley (ed.), Powder Metallurgy (selected chapters).
- ASM Handbook, Volume 7: Powder Metallurgy.
- Selected university course notes (indicative): KTH Powder Metallurgy topics and notes.

Materials Circular Economy and LCA

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 713	SEMESTER	7th Semester
COURSE TITLE	**Materials Circular Economy and LCA**		
TEACHING ACTIVITIES Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
		4 (2L + 2Lab/Comp)	6
COURSE TYPE	Skill development / Scientific area		
PREREQUISITES	Introduction to Materials Science and Engineering. Recommended: Thermodynamics and Materials Processing.		
TEACHING AND EXAMINATION METHODS	Lectures plus computer-lab sessions on life cycle thinking and LCA modelling; case studies; final project and 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	• Explain circular economy principles and their specific implications for materials and product systems. • Set up the goal and scope of an LCA study (functional unit, system boundaries, assumptions). • Perform simplified life cycle inventory (LCI) modelling and interpret key data requirements. • Interpret life cycle impact assessment (LCIA) results and understand main categories and limitations. • Compare circularity strategies (reuse, repair, remanufacture, recycle) using quantitative and qualitative criteria. • Communicate LCA and circularity results transparently, including uncertainty and sensitivity considerations.
General Skills	• Sustainability literacy and systems thinking • Data handling and modelling skills • Critical evaluation of assumptions and uncertainty • Teamwork on case-study-based projects

3. COURSE CONTENT

- Materials and sustainability: resource use, emissions, and circularity metrics (overview).
- Circular economy principles and strategies (design for R: reuse, repair, remanufacture, recycle).
- Life cycle thinking: product systems, functional unit, system boundaries, allocation.
- Life cycle inventory (LCI): data sources, primary vs secondary data, data quality.
- Life cycle impact assessment (LCIA): main categories and interpretation; limitations.
- Life cycle costing (LCC) and social LCA (overview).
- Circularity indicators and integration with LCA; design-integrated approaches.
- Case studies: metals, polymers, batteries/critical materials, composites; end-of-life scenarios.
- Software/lab sessions for simplified LCA modelling and scenario comparison.

4. LEARNING & TEACHING METHODS - EVALUATION

Teaching method	Face-to-face. Lectures, computer laboratories, and case-study workshops with a team project.
Use of ICT	Computer labs using an LCA tool (e.g., openLCA or equivalent) and spreadsheets; e-learning for datasets/templates; collaborative platforms for group work and reporting.
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

Activity	Workload/semester (hours)
Lectures	26
Computer laboratories / workshops	26
Team project and report	28
Independent study	52
Exam preparation	16
Final written exam	2
Total	**150**

Student evaluation	Assessment language: English. Methods: project/report and presentation (45%), written final exam (35%), quizzes/short assignments (20%). Students are informed via the course guide and e-learning announcements.

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

To be specified in EUDOXUS.

Additional bibliography for study

- ISO 14040/14044 standards (overview) and selected guidance documents.
- M. Finkbeiner (ed.), Life Cycle Assessment: Theory and Practice (selected chapters).
- Selected course notes on LCA and circular design (indicative): TU Delft / ETH LCA materials.
- Relevant journal review papers and case studies provided by the instructor.