GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2025-2026

Metal Extraction and Recycling (E065472)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 2)	English	Gent	lecture	35.0h
			seminar	25.0h
B (semester 2)	Dutch	Gent		

Lecturers in academic year 2025-2026

Bellemans, Inge	TW11	lecturer-in-charge
Vervynckt, Stephanie	TW11	co-lecturer

Offered in the following programmes in 2025-2026	crdts	offering
Bridging Programme Master of Science in Sustainable Materials Engineering	6	A
International Master of Science in Sustainable and Innovative Natural Resource Management	6	A
Master of Science in Chemical Engineering	6	A, B
Master of Science in Chemical Engineering	6	A, B
Master of Science in Materials Engineering	6	B
Master of Science in Sustainable Materials Engineering	6	A

Teaching languages

English, Dutch

Keywords

Recycling, primary raw materials vs. secondary, pyrometallurgical processes, hydrometallurgical processes, electrometallurgical processes, thermodynamics, thermodynamic software and databases, extraction and separation of metals, environmental and safety aspects

Position of the course

This course covers the basics regarding metallurgical processes (pyro-, hydro- and electrometallurgy). In addition, the building blocks of a metallurgical flowsheet are investigated. The production process of a number of metals is studied through several case studies. Insight is gained into the recycling problems and the recycling potential. The link to industrial reality and application is always made.

Contents

- General definitions in thermodynamics, first, second and third law of thermodynamics, thermodynamic quantities, Gibbs free energy and reaction equilibrium
- Different tools: Phase diagrams (binary and ternary), Ellingham diagrams, Predom diagrams, Pourbaix diagrams, Evans diagrams
- Basic principles and processes in extractive metallurgy (pyro-, hydro-, electro- and biometallurgy)
- Case studies for the production and recycling of various metals (e.g. Cu, Pb, battery materials) using pyro-, hydro-, electro- and biometallurgical processes in reality
- Flowsheet design: general rules for the design of a flowsheet
- Knowlegde management: data versus noise, design or experiment
- Quality, environmental, health and safety aspects

Initial competences

Basic chemistry knowledge from bachelor

Final competences

1 Understanding concepts regarding thermodynamics, basic processes in metal production, extractive metallurgy of different metals, recycling issues & potential and flowsheets
2 Applying concepts around thermodynamics and the tools provided (phase diagrams, Ellingham diagrams, Predom diagrams, Pourbaix diagrams, Evans diagrams)
3 Evaluating modern production techniques of base metals (copper, lead) and precious metals: environmental aspects of metal production (emissions, energy consumption,...), use of recycled raw materials
4 Use and interpretation of thermodynamic software and knowledge of its limitations
5 Design a scientifically and economically sound flowsheet
6 In group, investigate a unit process in the lab using a preparation based on a critical calculation of the system
7 Report in written English on the own lab research in a scientific manner

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Excursion, Lecture

Study material

Type: Syllabus

Name: Syllabus and extra information
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : No

Type: Slides

Name: Lecture slides
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : No

References

- P. Hayes, 'Process Principles In Minerals And Materials Production With A Focus On Metal Production And Recycling', Fourth edition, 2021
- M. E. Schlesinger, K. C. Sole, W. G. Davenport., 'Extractive metallurgy of Copper' 5th Edition, 2011
- D. R. Gaskell, 'Introduction to the thermodynamics of materials', Taylor&Francis, 2003
- F. Habashi, 'Handbook of extractive metallurgy', Wiley, 1997

Course content-related study coaching

In person: after class + by electronic appointment.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment

Examination methods in case of periodic assessment during the second examination period

Written assessment

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

- Periodic evaluation: written exam with closed book.
- Permanent evaluation: assessment of practical work (participation, attitude) and reports (preparation, participation, report, assessment PC software use)

Calculation of the examination mark

There are two parts to this course: practical work (permanent evaluation; counts for 4/20 of the total score) and exam (periodic evaluation; counts for 16/20 of the total score).
The final score is calculated on the basis of two sub-scores. Each of the sub-scores requires a minimum of 7/20 to pass the exam. If this is not the case and the final score would be a mark of 10 or more out of 20, it will be reduced to the highest unsuccessful mark (9/20).
For the purpose of retake examinations, transfer of partial scores is possible, provided that the student has obtained at least 10/20 for this part.