

## 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**

Offering	Language	Location	Teaching Methods	Hours
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**

Programme	credits	offering
<a href="#">Bridging Programme Master of Science in Sustainable Materials Engineering</a>	6	A
<a href="#">International Master of Science in Sustainable and Innovative Natural Resource Management</a>	6	A
<a href="#">Master of Science in Chemical Engineering</a>	6	A, B
<a href="#">Master of Science in Chemical Engineering</a>	6	A, B
<a href="#">Master of Science in Materials Engineering</a>	6	B
<a href="#">Master of Science in Sustainable Materials Engineering</a>	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
- Knowledge 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.