GHENT UNIVERSITY

Course Specifications

From the academic year 2017-2018 up to and including the

Modelling of Physical Processes in Metallurgy (E066180)

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

Credits	4.0	Study time	120 h	Contact hrs	30.0 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 2)	Dutch	seminar: practical PC room classes	7.5 h
		seminar: coached exercises	7.5 h
		lecture	15.0 h

Lecturers in academic year 2018-2019

Constales, Denis	TW16	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Master of Science in Sustainable Materials Engineering	4	A

Teaching languages

Dutch

Keywords

metallurgy, mathematical modelling, direct and inverse diffusion problems, free boundary problems, magnetic material characterisation, mechanical properties

Position of the course

Besides advanced, experimental methods also mathematical modelling plays an important role in the study of various physical phenomena and processes in materials science. In this course we deal with the systematic development and analysis of mathematical models, starting from the underlying physical laws, including the construction of a (semi-)analytical solution or a numerical algorithm. This task is undertaken through a number of practical problems from the recent scientific literature and, partly, from multi-disciplinary research in collaboration with the Department of Materials, Textiles and Chemical Engineering.

Contents

- Free and moving boundary problems: Precipitation and dissolution of spherical AlN particals in steel
- Modelling of shrinkage defects in castings.
- Multicomponent diffusion.: Fick's first low (intrinsical- and interdiffusion) and Fick's second low
- Kirkendall Effect.: Nonreciprocal diffusion and intrinsical diffusivities, Diffusion advection, Darken's analysis
- Inverse problems (parameter identification): Cooling strategy in continuous casting, Diffusion of Si and Al in Fe, A potential model for corrosion detection
- Aspects of magnetic material characterisation: Energy losses in magnetic materials, Magnetostriction
- Mechanical stress and deformation under strain.

Initial competences

The usual mastered knowledge from Analysis I and II, supplemented with elements from Introduction to Numerical Mathematics (baCTM2/baWE2).

Final competences

1 Knowledge of the concepts of fixed domain tranformation, moving boundary value problem; cost functional for an inverse boundary value problem; wel posedness of a boundary value problem; diffusion controlled growth; diffusion annealing; mechanical stress, deformation.

2 Insight in diffusion in solids, conservation laws; coupling of quasi static magnetic field equations with Preisach material model; relation between mechanical and electrical properties of magnetic materials; semi-analytical and numerical methods; design and mimimization of a cost functional for an inverse diffusion problem, reduction to a sequence of direct problems; origin of differences in shrinkage defects of rapidly and slowly freezing materials; Kirkendall effects and relation with 'vacancy wind'.

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

Lecture, seminar: coached exercises, seminar: practical PC room classes

Extra information on the teaching methods

Classroom lectures; Classroom problem solving sessions

Learning materials and price

College notes, 7 EUR Copies from books and journal papers.

References

- H.T. Banks and H.T. Tran, Mathematical and experimental modeling of physical and biological processses, CRC press, Boca Raton (2009)
- A.C. Fowler, Mathematical Models in the Applied Sciences, Cambridge University Press, Cambridge (1997)
- M.E. Glicksman, Diffusion in Solids, John Wiley & Sons, New York (2000)
- M. Rappaz, M. Bellet and M. Deville, Numerical modelling in materials science and engineering, Springer-Verlag, Berlin (2003)
- A.A. Samarskii and A.P. Mikhailov, Principles of mathematical modelling, Taylor & Francis, New York (2002)

Course content-related study coaching

Individual consulting after the lectures or via email or appointments.

Evaluation methods

end-of-term evaluation

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

Written examination with open questions

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

Written examination with open questions

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Calculation of the examination mark

Evaluation during examination period