University of Miskolc

Faculty of Materials Science and Engineering
Antal Kerpely Doctoral School of Materials Science & Technology

Transport processes

Dr. Tóth Pál

COURSE DESCRIPTION

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Transport processes

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Lecturer

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Target group

The course is offered for all students of the Kerpely Doctoral School, especially in the field of flow, heat transfer, strength of materials and numerical modelling.

Language

English or Hungarian.

Scope

Understanding continuum mechanics and transport processes. Basic transport equations (mass, pulse and energy transport), their applicability frameworks and solutions. Introduction to numerical flow modelling.

Methodology

The subject is taught in a lecture or consultation system. The number of students enrolled determines the form of education: we are organizing a lecture for at least 5 students. The subject mainly describes the analytical solutions of the transport equations, but the empirical and numerical methods of solutions are also described. The course will be delivered through lectures or through released materials on the subject. An integral part of the subject is the mandatory semi-annual tasks to be solved, which will require independent work.

Constituent topics

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Test questions:

1. *Mathematical and physical concepts: physical fields, scalar, vector and matrix types, differential and integral operators, partial differential equation systems.*
2. *Developing a system and model approach. What is the system, where are its boundaries, what assumptions can be made, what are their effects?*
3. *Transport equations and their derivation. Intuitive meaning and visualization of each member.*
4. *Solving simple separable equation problem traceable to simple diferential equations. Binary diffusion of dilute components, thermal conductivity.*
5. *Solving the problems of a linear differential equation.*
6. *Solving complex, multivariate or non-separable problems.*
7. *Problems with multivariate coupled partial differential equation systems: convection heat transfer. Similarity conditions, empirical methods.*

8. *Turbulence modeling, Reynolds-averaged Navier-Stokes equation.*
9. *Thermal radiation modelling. Configuration factors, spectra, Monte Carlo method.*
10. *Molecular processes of transport processes. Calculation of thermal conductivity, viscosity and diffusion factors.*
11. *Introduction to Numerical Methods of Transport Processes. Computational Fluid Dynamics (CFD). Introduction to non-intrusive measurement techniques of thermal and flow problems (Doppler anemometry, laser visualization, light scattering, holography, Schlieren).*

Recommended literature

1. R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot : Transport Phenomena. Wiley, 2008
2. Frank P. Incropera, David P. DeWitt : Fundamentals of Heat and Mass Transfer , John Wiley & Sons, 2002.
3. C. E. Baukal, Jr.: Heat Transfer in Industrial Combustion, CRC Press LLC, 2000

Completion, examination

Completion of semester assignments, oral exam.

Relevant topics for the complex examination

1. What is the gradient of a physical field?
2. What is the driving force of transport processes?
3. What kinds of transport phenomena you know of?
4. What are the limits of continuum mechanics?
5. There is a given complex problem and a modelling mathematical method. List the inaccuracies, errors, and theoretical mistakes of the method (if any). How much accuracy can be expected from the given model? How can the method be implemented?
6. There is a complex problem. How would you estimate the output of the process?
7. There is a complex problem. How would you estimate the output error of the process?
8. List 5 macroscopic processes that cannot be sufficiently modelled by the methods of transport processes.
9. List 5 macroscopic processes that are modelled satisfactorily and routinely with the methods of transport processes.