Course: Transport Phenomena (160889)		
Language: English		
Lecturer: Assistant Professor Krunoslav Žižek, PhD Full Professor Jasna Prlić Kardum, PhD		
TEACHING	*WEEKLY*	*SEMESTER*
Lectures	3	45
Laboratory	1	15
Seminar	1	15
		Overall: 75
		ECTS: 7

PURPOSE:

To gain knowledges on transport phenomena (momentum, heat and mass transfer) that are fundament and core component for chemical engineering discipline.
To understand, analyse and describe mechanical processes, thermal and equilibrium separation process technologies using phenomenological equations that rely on three elementary physical processes: momentum, energy, and mass transport.

THE CONTENTS OF THE COURSE:

The 1st week
Opening lecture – presenting the course methodology and introducing core terms for the course (process control volume, chemical engineering and its paradigms, transport phenomena, unit operations, technological process).

The 2nd week
General law of conservation, Stationary vs. non-stationary process, The flux, Mechanisms of transport phenomena, Newton's law of viscosity, Rheology, Introduction to momentum transfer in fluids.

The 3rd week
Conservation laws for hydrodynamic systems (Equation of continuity, The law of conservation of momentum, Bernoulli equation), Detection of some terms in Bernoulli equation. Calculation examples.

The 4th week
Flow types, Reynolds number, Analysis of laminar flow in pipes, Velocity and momentum flux distribution, Energy loss in terms of pressure drop. Calculation examples.

The 5th week
Analysis of transitional and turbulent flow in pipes, Theory of boundary layer, Causes of turbulence occurrence, Estimation of energy loss in terms of pressure drop, Moody diagram, Flow through pipeline. Calculation examples.
Lab assignment I: Estimating the power of a pump needed for transportation of fluid in a pipeline

The 6th week
Analysis of the flow around obstacles, Boundary cases, Irreversible energy loss in term of drag force and its estimation for various flow regimes, Drag factor, Settling of a solid particle in a fluid. Calculation examples.
Lab assignment II: Flow around obstacles

The 7th week
Analysis of fluid flow in mixing units, Degree of mixing, Flow regimes in a mixing unit, Totality of resistances.
Study of the flow through bed of particles, Description of underlying geometry, Irreversible energy loss in terms of pressure drop and its estimation for narrow and wide pores, Resistance factor, Scoping fluidization and filtration processes using perspective of this flow phenomenon. Calculation examples.

The 8th week
The 1st partial exam

The 9th week
Thermal properties of bodies. Fourier’s law. Stationary heat conduction through bodies of different geometry. Calculation examples.

The 10th week
Non-stationary heat conduction. Transient heat conduction in finite and semi-infinite solids. Temperature distribution in the body. Calculation examples.
Lab assignment III: Non-stationary conductive heat transfer

The 11th week
Convection heat transfer. Thermal boundary layer. Concept of hydrodynamic and thermal boundary layers. Newton’s law. Convective heat transfer coefficient. Calculation examples.

The 12th week
Overall heat transfer; Determination of overall heat transfer coefficient, thermal resistance and mean temperature difference. Non-dimensional numbers for heat transfer. Dimensionless correlation equations for heat transfer in forced convection, free convection and phase changes. Radiation heat transfer. Calculation examples.
Lab assignment IV: Convective heat transfer

The 13th week
Mass transfer. Stationary diffusion. Mass transfer coefficient. Equimolar-counter diffusion. Diffusion through a stagnant layer. Non-stationary diffusion. Convective mass transfer. Dimensionless correlation equations. Interphase mass transfer. Calculation examples.

The 14th week
Analogies in momentum, heat and mass transport. Calculation examples.
Lab assignment V: Mass transfer, equimolar-counter diffusion

The 15th week
The 2nd partial exam

Lectures are consecutively followed by lab tutorials and seminars.

GENERAL AND SPECIFIC COMPETENCE:

Acquiring knowledges on transport phenomena (momentum, heat and mass transfer), conservation laws they involve, and on the effects of flow regime (that is hydrodynamic conditions) on heat and mass transfer. To learn about momentum, heat and mass analogy.
These are essential for gaining subsequent knowledges on the study programme.

KNOWLEDGE TESTING AND EVALUATION:

These are realised by implementing:

1. the screen of their knowledge via preliminary exams related to laboratory assignments, furthermore by two partial exams and finally by oral exam,
2. continuous monitoring of students: class attendance (both lectures and seminars), impression of seminar essay.

MONITORING OF THE COURSE QUALITY AND SUCCESSFULNESS:

By student questionnaire.

LITERATURE:

W.J. Beek, K.M.K. Muttzall, Transport phenomena, John Wiley & Sons Ltd, UK, 1975.

R.W. Fahrien, Fundamentals of Transport Phenomena, Mc Graw-Hill, New York, 1983.

R.G. Griskey, Transport Phenomena and Unit Operations, John Wiley & Sons Ltd, UK, 2006.

R. Byron Bird, Transport Phenomena, Revised 2nd Edition, John Wiley & Sons Ltd, UK, 2006.

E.L. Cussler, Diffusion: Mass Transfer in Fluid Systems, 3rd Ed., Cambridge University Press, 2007.

J.R. Welty, C.E. Wicks, R.E. Wilson, G.L. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th Ed., John Wiley & Sons Ltd, UK, 2008.

Documentation on lectures and seminars for the course Transport Phenomena provided by lecturers (Assistant Professor Krunoslav Žižek, PhD and Full Professor Jasna Prlić Kardum, PhD).