Brief description of the content that will be covered under the course Modelling approaches of Nanoscale filtration processes of solutions and Suspensions

Elements of the field theory. The gradient of a scalar field, divergence and curl of a vector field. Noblat's and Laplace's operators. The law of conservation of scalar quantity and its use for the derivation of the equation of the heat distribution in the fluid and convective diffusion equation. The Laplace equation.

Potential discontinuous flows of liquid or gas, the derivation of the Navier-Stokes equations. The Reynolds number. Euler's equations for an ideal fluid and "creeping" Stokes' flow of a viscous fluid. The Poisson equation for the electric potential distribution. The electric double layer.

Approximate methods for solving boundary value problems for heat conduction and diffusion equations. The physical "drawback" in parabolic equations. The method of integral relations (torques) - a method of Goodman.

Membrane separation processes of liquid solutions and suspensions. Classification of the membrane processes and their advantages over conventional methods of separation. The phenomenon of concentration polarization during separation of non-electrolyte solutions.

The theory of reverse osmosis and nanofiltration separation of solutions of non-electrolytes and electrolytes. The derivation of the boundary conditions of the discontinuity of the electric potential and electrolyte concentration at the interfaces.

Usage of charged nanofiltration membranes for desalination of electrolyte solutions. Performance and retention rate of the membrane. Optimal filtering modes.

Surface modification of ultrafiltration membranes - effects of the asymmetry of retention coefficient and drop of the electric potential (streaming potential) for bilayer membranes. The use of ultrafiltration membranes for purification of well fluid from oil impurities.

Probability-sieve model for microfiltration of polydisperse suspensions taking into account pore blocking of the membrane during time. Use of microfiltration in the electronics industry and technology of drilling fluids purification processes.

Brief description of the content that will be covered under the course Modelling approaches of Nanoscale filtration processes of solutions and Suspensions

Properties and classification of disperse systems. The free and linked dispersions. Classification of disperse systems on the state of aggregation. Coarse and highly dispersed systems - extreme dependence of the number of molecules at the surface to the number of molecules in the physical volume. Capillary phenomena. Wetting and spreading.

Elements of thermodynamics of nonequilibrium processes. The relationship between the thermodynamic forces and fluxes - Onsager relations. Electrokinetic phenomena in porous media: electro-osmosis and thermal flow, potential and current flow, electrical conductivity and thermal diffusivity.

Disjoining pressure. The dispersion, electrostatic and structural components of disjoining pressure. Molecular and electrostatic interactions of colloidal particles. The DLVO theory. Deryagin's approach to the calculation of the energy and force of interaction between the two curved surfaces. Interaction of charged particles with a charged surface of the pore in the electrolyte solution. Influence of surface hydrophobicity.

Ion-exchange membranes. Electrodialysis of electrolyte solutions. Application of electrodialisys to sea water desalination and demineralization of electrolyte solutions. The current-voltage characteristics of the membrane and the concept of the limiting current. Underlimiting and overlimiting modes of electrodialysis. The effects of asymmetry of current-voltage characteristic and diffusion permeability of ion-exchange membranes and their modeling.

Cell model of porous media (membranes). Determination of hydrodynamic permeability of the medium (membrane) as an aggregate of porous particles. The boundary conditions of sticking, slipping and a jump of shear stresses. Influence of surface forces on the boundary conditions on the porous surface.

Different ways of modeling of porous media using an ensemble of regular packed and partially or totally porous particles. Kozeny's constant and its theoretical confirmation. Darcy's and Brinkman's models of a porous medium.