Transfer Phenomena I

Calendar: 3rd semester

Contact Hours: 37h50 T + 30h00 TP + 7h50 OT

Scientific Area: Processos em Engenharia Química e Biológica

Learning outcomes of the curricular unit
In the end of the semester students should: acquire basic knowledge about transport of momentum and heat; apply the knowledge acquired in solving problems involving fluid flow and heat transfer; know how to establishing balance sheets of thermal energy and boundary conditions.
After approval students should have the ability to: design transport systems of a fluid; understand the fundamentals of energy transfer, being able to apply it for solving practical problems. Identify the processes involved in heat transfer to calculate the amount of heat transferred in one-dimensional systems; determine the temperature profile and the amount of heat transferred in one-dimensional systems involving heat generation; analysis of heat transfer equipment, in order to select and design heat exchangers. Select and design isolation equipment

Syllabus
Chapter I: 1. Introduction; 2. Dimensional Analysis; 3. Momentum Transfer and General Balances: Molecular Transport Equation, Velocity Profiles in Laminar Flow; 4. Mass Transfer: Molecular Transport Equation; 5. Energy transfer: Molecular Transport Equation. Bernoulli's equation; 6. Viscosity; Classification of Fluids, Rheology of fluids. Reynolds number, fluid flow under laminar and turbulent regime; 7. Pressure loss. Friction factor; pressure loss in pipes and in pipe fittings, flow meters. Pumps: centrifugal pump sizing
Chapter II: 1. Mechanisms of heat transfer; 2. Fourier's law, Newton's Law of cooling; Stefan-Boltzmann law; 3. Thermal Conduction: Conduction at steady state, one-dimensional conduction in plans and radial systems; with convection and with energy production. Thermal resistances in series, overall coefficient of heat transfer. Thermal insulation; 4. Heat transfer in transient state: finite thickness plate, cylinder and sphere. Analytical method and graphical method.

Demonstration of the syllabus coherence with the curricular unit's objectives
This curricular unit is organized in two main chapters, in which the first corresponds to the study of movement transport. The themes are subdivided in 7 modules with the aim of lecturing the subjects with adequate insightful. Thus, in 1st and 2nd modules the basic concepts are lectured, while in 3rd to 5th modules the equations for moment, mass and energy transfer are introduced. The 6th module refers to the turbulent and laminar flux conjugated with the viscosity study. Finally, this chapter ends with pressure losses in pipes and pumps dimensioning.
The 2nd chapter corresponds to heat transport and includes the importance of thermal isolation. In the end of this chapter the heat transfer in transient state is studied.

Teaching methodologies:
Theoretical material will be presented to promote the involvement and participation of all students, by developing their reasoning skills and stimulating their critical thinking. In practical classes, students can solve exercises to apply the concepts taught by lectures, contributing for a better integration of the knowledge.

Demonstration of the coherence between the teaching methodologies and the learning outcomes.
This curricular unit is structural for this study cycle and aims to give the students solid competences in the subjects of heat and moment transport. That knowledge is essential to other more advanced curricular units. It is also intended that student gain critical attitude during the learning process for acquisition of knowledge and skills.
The teaching methods are consistent with the objectives of the course because: 1 - exposure of contents by the teacher will allow the acquisition of solid knowledge; 2 - solving problems involving fluid flow and heat transfer will instill students with the knowledge and autonomy. The evaluation system was designed to measure the extent to which skills have been developed by students.