

# PRINCIPLES OF ENVIRONMENTAL ENGINEERING

Prof. Agostina Chiavola

## **Program**

*Stoichiometry and kinetic of chemical reactions.* Reaction order and its determination by integrated and differential methods. Influence of temperature on the reaction rate. Principles of Mass balance representation. (10h)

Ideal reactors. Ideal isotherm reactors (batch, CFSTR, PFR). Analysis of the response of CFSTR and PFR under dynamic and steady-state conditions, to step and pulse input signals for different reaction orders. Analysis of series of CFSTR e PFR. Effect of the recycle on PFR and CFSTR. Comparisons of efficiency and conversion rate. Variable volume reactors: Equalization (principles of operation, function and volume determination) and Sequencing Batch Reactors. (mass balance representation) (20h)

*Characterization parameters of environmental compartments.* Biochemical Oxygen Demand (BOD) Application of Thomas and differential methods. Chemical Oxygen Demand (COD). Nitrogen. Phosphorous. Solids. (20h)

*Biochemical kinetics.* Microbial specie characterization. Metabolism classification. Bacterial growth. Biochemical kinetic equations. Michaelis-Menten equation. Rate and specific rate of growth. Monod equation. Substrate and microorganism mass balances to suspended biomass CFSTR with and without sludge return, and with sludge waste from the reactor and the sludge return line. Average sludge age. Minimum sludge age. Hydraulic residence time. Organic and volumetric loading factors. Oxygen requirements. Substrate and microorganism mass balances to suspended biomass PFR with sludge return and sludge waste. Substrate and microorganism mass balances to suspended biomass SBR. Comparison of biological processes in CFSTR, PFR and SBR. Sludge Volume Index. Nitrification process. (30h)

*Unit operations.* Settlement of type I, II, III and IV. Solid Flux theory. Adsorption. (10)

## **Teaching methods**

The course consists of both theory classes and numerical exercise classes.

Schedule of the course is published in the web site of the Bachelor degree.

## **Study materials**

Audio lessons in Google classroom (access code: mdoukun)

Pdf slides in the Moodle platform

Books:

- L. D. Benefield, J. F. Judkins, B. L., Weand, Process chemistry for water and wastewater treatment, Prentice Hall, Inc., USA.
- R. E. Treybal, Mass transfer operations, McGraw-Hill, Inc., USA.