Master Course in Energy Engineering

Academic Year 2020/2021

ADVANCED HEAT AND MASS TRANSFER

Syllabus

Instructor:	**Gianfranco Caruso**
Course Objectives:	This course is designed to introduce an intermediate and advanced study of the phenomena of heat and mass transfer, to develop methodologies for solving a wide variety of practical engineering problems, and to provide useful information concerning the performance and design of energy systems and processes. A deeper knowledge about momentum, heat and mass transfer in two-phase flows is also included. Weekly exercises will give the student practice in problem solving techniques and Self-Evaluation Tests
Prerequisites:	Basic elements of heat transfer, hydraulics, and thermodynamics (Applied Physics)
Web:	http://elearning2.uniroma1.it/course/view.php?id=4927
Learning Outcomes:	Students completing this course are expected to: • internalize the terminology and physical principles associated with heat and mass transfer; • be able to identify pertinent transport phenomena for any process or system involving heat and mass transfer; • be able to use requisite inputs for computing heat transfer and mass rates and/or material temperatures and species concentrations; • explain the mechanisms for momentum transfer for flow inside ducts and around solid bodies and how these mechanisms influence heat and mass transfer. • specify and explain the fundamental transport equations that describe steady- and unsteady-state heat and mass transfer and specify initial and boundary conditions • be able to develop appropriate models of real processes and systems and to draw conclusions concerning process/system design or performance; • identify and solve simple problems about two-phase flow and heat transfer.
Content:	Fundamental and energy units; Units conversion; Review on Thermodynamics; Thermo-physical and transport properties; Dimensionless Numbers; Conduction heat transfer - The heat

	equation; Steady heat conduction in special conditions and geometries; Transient conduction; Numerical Analysis of heat conduction; General conservation equations - Conservation of mass; Conservation of momentum; Conservation of energy; Radiation heat transfer; Two-phase flows: characteristic variables and properties; Two-phase flows: momentum and energy equations; Convection transfer - Boundary Layers; External Flows in forced convection; Internal flows: Friction and heat transfer in forced convection; Turbulent flows; Natural convection; Heat Exchangers; Two-phase flow regimes; Boiling: introduction - Bubble equilibrium, nucleation, dynamics; Pool boiling - The boiling curve; Subcooled and saturated flow boiling; Critical heat flux and Post dry-out heat transfer; Pressure drops in Two-phase flows; Condensation - The Nusselt's theory; Condensation inside and outside tubes; Condensation in the presence of noncondensable gases
Reference text materials:	• Course notes available on: http://elearning2.uniroma1.it/course/view.php?id=4927 • Other useful References: • **A Heat Transfer Textbook, 5th ed, John H. Lienhard - Available here: https://ahtt.mit.edu/** o Fundamentals of Heat and Mass Transfer, 7th Edition, by T.L. Bergman, A.S Lavine, F.P. Incropera and S. P. Dewitt. John Wiley and Sons, 2011 o Convective Boiling and Condensation, 3rd Ed., by J.G. Collier and J.R. Thome. Oxford University Press, 1994.
Examination:	Two written examinations/quizzes during the semester (90 min long); Final oral examination (on request). Self-Evaluation Tests on the e-learning site (in class) The first Self- Evaluation Test (SET-0, at home) is mandatory.
Grading:	Mid- and End-Term examinations/quizzes (45%+45%, maximum mark 28). Final oral (not mandatory if tests result > 23, 20%, max added mark +3).