Course Name						
FUNDAMENTALS OF TRANSPORT PHENOMENA						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 317E	5	2,5	4	2	1	-

Department/Program	Metallurgical and Materials Engineering
Course Type	Required — **Course language**: English
Course Prerequisites	None

Course Category by Content, %	**Basic Sciences**	**Engineering Science**	**Engineering Design**	**General Education**
		80 %	20 %	

Course description	Introduction, Dimensions and units of measurement, The concept of viscosity, Steady-state unidirectional flow, The differential equations of flow, Applications of differential equations of flow, Turbulent flow, Overall material and energy balance in fluid flow, Applications of the overall energy balance, Thermal conductivity and steady state conduction, Unsteady state conduction of heat, Heat transfer by convection, Heat transfer by radiation, Mass diffusivity: steady state diffusion, Unsteady state diffusion, Mass transfer by convection, Mass transfer models and correlations, Chemical rate phenomena, Applications of rate phenomena theory, Flow behavior in chemical reactors
Course Objectives	Transport Phenomena is an engineering course designed to introduce students to the theory and applications of fluid mechanics, also known as momentum transport. The principal means of analysing and understanding fluid motion comes from mass, momentum and energy balances applied to fluids. The first part of the course will focus on macroscopic or integral balances, predominantly those of mass, momentum, and mechanical energy, applied to finite control volumes of fluids. This part provides the most practical content of the course, as the students will learn general design principles of flow in pipes and pipe networks. The second part of the course will focus on microscopic or differential balances, predominantly those of mass and momentum, applied to differential (infinitesimal) volumes of fluids. This part leads to fundamental differential equations, the Equation of Continuity and the Navier-Stokes equations, which govern all (actually, nearly all) fluid motion, and whose application can provide substantial information on fluid velocity patterns, pressure distributions and other stresses arising from or associated with the flow
Course learning outcomes	Upon successful completion of this course, a student should be able to: 1. Ability to apply knowledge of mathematics (calculus and differential equations) and physics (laws of conservations of mass, momentum and energy) to transport phenomena related to materials, 2. Ability to analyze transport phenomena related to materials, by formulating the problems mathematically (into differential equations with proper boundary conditions) and solving them analytically or with the help of equation-solving tools, 3. Ability to design materials processing (e.g., casting, welding, heat treating, crystal growth and semiconductor processing) based on transport phenomena 4. Knowledge of contemporary issues in transport phenomena in materials processing, e.g., computer simulation of materials production and processing.
Textbook	Themelis N.J., Transport and Chemical Rate Phenomena, Gordon & Breach, 1995.
Other references	• Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, Wiley, 1960. • Szekely J. and Themelis N.J., Rate Phenomena in Process Metallurgy, Wiley-Interscience, 1971. • Geiger G.H. and Poirier D.R., Transport Phenomena in Metallurgy, Addison-Wesley, 1973. • Geankoplis C.J., Transport Processes: Momentum, Heat, and Mass, Allyn & Bacon, Inc., 1983.
Homework & projects	All homework problems are to be **handed-in** a week after they are assigned. Homework problems may be used as a source for exams.
Laboratory work	NONE
Computer use	NONE
Other activities	NONE

Assessment criteria	Activities	**Quantity**	**Effects on grading, %**
	Midterm exams	**1**	**25 %**
	Quizzes	**3**	**15 %**
	Homework	**3**	**15 %**
	Projects	**-**	**-**
	Term Paper/Project		**-**
	Laboratory Work	**-**	**-**
	Other Activities	**-**	**-**
	Final exam	**1**	**45 %**

COURSE PLAN

Weeks	Topics	Course outcomes
1	Introduction, SI Units, Temperature Pressure and Ideal Gas Law, Properties of Fluids	1, 2
2	Types of Fluid Flow and Reynolds Number, Newtonian Fluids	1, 2
3	Viscosity and its Units, Non-Newtonian Fluids	1, 2
4	Laminar Flow and Momentum Balance, Application of Differential Equations	1, 2
5	Turbulent Flow, Friction Factor, Fluidised Bed	1, 2
6	Conservation of Energy	1, 2
7	Friction Losses, Flow Measurement	1, 2
8	Flow and Vacuum Production, Fourier's Law and Thermal Conductivity	1, 2
9	Flow and Vacuum Production, Fourier's Law and Thermal Conductivity	1, 2
10	Heat Transfer and The Energy Equation	1-3
11	Conduction of Heat in Solids, Radiation Heat Transfer	1-3
12	Thermal Behaviour of Metallurgical Packed-Bed Reactors	1-3
13	Diffusion in Solids Liquids and Gases, Fick Laws	1-3
14	Mass Transport in Fluid Systems	1-3

Relationship between the Course and Metallurgical and Materials Engineering Curriculum

	Program Outcomes	Level of Contribution		
		1	2	3
1	Ability to apply the knowledge of mathematics, science, and engineering principles to solve problems in metallurgical and materials engineering (ABET:a)			X
2	Ability to characterize materials using standard and/or self designed experimental methods and to evaluate the results (ABET:b)			
3	Ability to design a system or a process, taking into consideration of the desired specifications, quality, ethics and environment (ABET:c)	X		
4	Ability to communicate both orally and in the written form and to take part in, and provide leadership of the teams in the elucidation of engineering problems (ABET:d, g)			
5	Ability to define, formulate and solve engineering problems in the development, production, processing, protection and usage of engineering materials (ABET:e)			X
6	An understanding of professional and ethical responsibilities (ABET:f)			
7	An understanding of current/contemporary issues and impact of engineering solutions in broad cultural, national and global levels (ABET:h, j)		X	
8	A comprehension of the nature of engineering progress closely linked with the development of new materials and production processes. An ability to engage in life-long learning and a recognition of its necessity (ABET:i)			
9	Ability to use essential tools and techniques of modern engineering in the development, production, processing, protecting of the existing and new engineering materials (ABET:k)		X	

1: Little, 2: Partial, 3: Full

Course relationships with major elements of the field and material classes

		Level of Contribution		
		1	2	3
MAJOR ELEMENT OF THE FIELDS	STRUCTURE		X	
	PROPERTIES		X	
	DESIGN EXPERIMENT/ANALYSE DATA	X		
	PROCESSING	X		
	COST/PERFORMANCE	X		
	QUALITY/ENVIRONMENT	X		
	DESIGN PROCESS OR PRODUCT		X	
MATERIAL CLASSES	METAL		X	
	CERAMICS	X		
	POLYMERS			
	COMPOSITES			

1: Little, 2: Partial, 3: Full

Prepared by	Date	**Signature**
Prof. Dr. Cüneyt ARSLAN	March, 2013	