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	MET 213E		

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

Course description	Introduction and basic concepts, Dimensions and units of measurement, General overview of transport phenomena including various applications, Types of fluid flow and Reynolds number, The concept of viscosity & kinematic viscosity and viscosity calculations of fluids, Newton's law, Newtonian and non-Newtonian fluids, Applications of differential equations of flow, Laminar Flow & Momentum Balance, Equation of continuity and the momentum equation, Application of Navier-Stokes' equation, Turbulent and complex flows, Heat transfer mechanisms, Fourier's law of heat conduction, Thermal conductivity of materials, Conduction of heat in solids, Definition of fluxes-Fick's laws, Diffusion in different media (solids, ceramics materials, liquids, etc.)
Course objectives	The objective of this engineering course is to provide to the student a sufficient background to be able to understand the fundamental phenomena, governing equations and assumptions used in the analysis of transport processes. We address aspects of three fundamental transport processes, momentum, heat and mass. After completing the class, students will be able to develop a background in the transports phenomena which are significant to be successful in many theoretical and practical problems in the fields of the laboratory practices, pilot plants or industrial operations implementations.
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	• Transport Phenomena in Materials Processing, D.R. Poirier, G.H. Geiger, The Minerals, Metals & Materials Society, 2016. • Fundamentals of Fluid Mechanics, B.R. Munson, T.H. Okiishi, W.W. Huebsch, A.P. Rothmayer, 7th Ed., Wiley & Sons, 2012.
Other references	• Transport and Chemical Rate Phenomena, Themelis N.J., Gordon & Breach, 1995. • Transport Phenomena, Bird R.B., Stewart W.E., and Lightfoot E.N., Wiley, 1960. • Rate Phenomena in Process Metallurgy, Szekely J. and Themelis N.J., Wiley-Interscience, 1971. • Transport Phenomena in Metallurgy, Geiger G.H. and Poirier D.R., Addison-Wesley, 1973. • Transport Processes: Momentum, Heat, and Mass, Geankoplis C.J., Allyn & Bacon, Inc., 1983.
Homework & projects	None
Laboratory work	None
Computer use	None
Other activities	None

Assessment criteria	**Activities**	**Quantity**	**Effects on grading, %**
	Midterm exams	**1**	**30 %**
	Quizzes	**5-6**	**30 %**
	Homework	**-**	**-**
	Projects	**-**	**-**
	Term Paper/Project		**-**
	Laboratory Work	**-**	**-**
	Other Activities	**-**	**-**
	Final exam	**1**	**40 %**

COURSE PLAN

Weeks	Topics	Course outcomes
1	Introduction to transport phenomena; Basic concepts	1
2	Properties of Fluids; Types of fluid flow and Reynolds number, Newton's Law, Viscosity and Kinematic viscosity, Viscosity of gases, Example problems	1, 2
3	Properties of Fluids; Viscosity of liquids, Non-Newtonian fluids, Example problems	1, 2
4	Laminar Flow & Momentum Balance: Momentum balance, Flow of a falling film, Fully developed flow between parallel plates, Fully developed flow through a circular tube, Example problems	1, 2, 3
5	Laminar Flow & Momentum Balance: Equation of continuity and the momentum equation, Application of Navier-Stokes' equation, Example problems	1, 2, 3, 4
6	Turbulent and complex flows: Friction factors for flow in tubes, Flow in noncircular conduits, Flow past submerged bodies, Example problems	1, 2, 3
7	Turbulent and complex flows: Flow through porous media, Fluidized beds, Example problems	1, 2, 3, 4
8	Midterm	
9	Fourier's Law & Thermal conductivity of materials, Example problems	1, 2, 3
10	Thermal conductivity of materials, Example problems	1, 2, 3
11	Conduction of heat in solids: The energy equation for conduction, Steady-state one-dimensional systems, Transient systems, Finite dimensions, Example problems	1, 2, 3, 4
12	Conduction of heat in solids: Transient conditions, Infinite and semi-infinite, Example problems	1, 2, 3, 4
13	Fluxes-Fick's laws, Diffusion in solids, Example problems	1, 2, 3, 4
14	Diffusion in ceramic materials, Diffusion in semiconductors, Diffusion in liquids, Diffusion in gases, Example problems	1, 2, 3, 4

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)		**X**	
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			
	PROPERTIES		**X**	
	DESIGN EXPERIMENT/ANALYSE DATA		**X**	
	PROCESSING		**X**	
	COST/PERFORMANCE			
	QUALITY/ENVIRONMENT			
	DESIGN PROCESS OR PRODUCT		**X**	
MATERIAL CLASSES	METAL			**X**
	CERAMICS		**X**	
	POLYMERS			
	COMPOSITES		**X**	

1: Little, 2: Partial, 3: Full

Prepared by	**Date**	**Signature**
Prof.Dr. Cüneyt ARSLAN Assoc.Prof. Dr. Güldem KARTAL ŞİRELİ	December, 2017	