Course Name						
Transport Phenomena						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 242E	4	3	5	2	2	-

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 analyzing 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	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	1. Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, Wiley, 1960. 2. Szekely J. and Themelis N.J., Rate Phenomena in Process Metallurgy, Wiley-Interscience, 1971. 3. Geiger G.H. and Poirier D.R., Transport Phenomena in Metallurgy, Addison-Wesley, 1973. 4. 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	Being able to work with computer programs MS Word and MS Excel			
Other Activities				

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 %
	All exams and quizzes will be conducted as open-book.		

COURSE PLAN

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

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)			
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 and surface treatment 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			
MATERIAL CLASSES	METAL	x		
	CERAMICS	x		
	POLYMERS	x		
	COMPOSITES	x		

1: Little, 2. Partial, 3. Full

Prepared by	Date	**Signature**
Prof. Dr. Cüneyt ARSLAN	25.12.2009	

Course Name						
Physical Metallurgy						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET311E	5	3	5	3	-	-

Department/Program	Metallurgical and Materials Engineering			
Course Type	Required		**Course Language**	English
Course Prerequisites	Met 221E min FF			
Course Category by Content, %	**Basic Sciences**	**Engineering Science**	**Engineering Design**	**General Education**
		80 %	20 %	
Course Description	This course aims to introduce a theoretical basis for understanding how structure is controlled by means of providing a link between various transformations taking place in materials and the resulting microstructural and physical properties. For this reason, it is a mandatory course for the three options of the Metallurgical and Materials Engineering department.			
Course Objectives	**1.** To introduce the field of Physical Metallurgy and some related applications; to provide phenomenological explanations for plastic deformation, dislocations and dislocation interactions and their contributions to the slip mechanism. **2.** To explain qualitatively vacancy formation in crystalline materials; concept of diffusion and various diffusion mechanisms in crystals; the importance of interface concept and their classification, dihedral angle and final microstructure relations. **3.** To explain the phenomena of nucleation and solidification by using Arrhenius type equations and to demonstrate, in detail, the thermodynamic and kinetic aspects of phase transformations on the structure of materials. **4.** To describe the morphologies of the phases during phase transformations (nucleation, crystal growth, solidification and precipitation mechanisms and the effect of deformation on recovery, recrystallization and grain growth. **5.** To describe the Fe-C phase diagram and the TTT diagrams for steels and describe the pearlite, austenite, bainite and martensite phases and to design suitable heat treatment procedures for annealing, tempering and solutionizing and to predict the age hardening behavior of an alloy on the basis of its phase diagram and composition. **6.** To provide information on diffusionless transformations, shape memory alloys: the Ni-Ti and other example systems and its martensitic reactions. To motivate students for continuous learning about Special Topics in Materials Science related to Physical Metallurgy using their basic knowledge gained during the course.			
Course Learning Outcomes	**1.** To understand the field of Physical Metallurgy and learn phenomenological explanations related to dislocations and dislocation interactions and their contributions to the slip mechanism during plastic deformation; and be able to calculate the critical shear stress and most favored slip directions in different lattices to comprehend the concept of the critical resolved shear stress and Schmid factor. **2.** To learn the vacancy formation in crystalline materials; concept of diffusion and various diffusion mechanisms in crystals; the importance of interface concept and its classification, dihedral angle and final microstructure relations and to be able to solve the problems related to first and second Fick's law and new phase formation during diffusion. **3.** To understand the phenomena of nucleation and solidification by using Arrhenius type equations and thermodynamic and kinetic aspects of phase transformations on the structure of materials. **4.** To understand how the different phase morphologies occur during phase transformations (nucleation, crystal growth, solidification and mechanisms precipitation);learn the effect of deformation on recovery, recrystallization and grain growth and differentiates their morphologies. **5.** To learn Fe-C phase diagram and TTT diagrams for steels and to describe the pearlite, austenite, bainite and martensite phases and to be able to design suitable heat treatment cycles and post treatment (annealing, tempering) to yield final desired properties. **6.** To predict the possibility of age hardening behavior of an alloy on the basis of its phase diagram and composition. To learn diffusionless transformations, Shape memory effect and the alloys having this behavior: the Ni-Ti and other example systems and its martensitic reactions.			
Textbook	- John D. Verhoeven, "Fundamentals of Physical Metallurgy", John Wiley & Sons, New York, 1974. - Robert E. Reed-Hill, "Physical Metallurgy Principles", Brooks/Cole Engineering Division, Monterey, CA, 1973.			
Other References	**-William F. Hosford, "Physical Metallurgy", Taylor & Francis, 2005**			
Homework & Projects	**There is an optional term project under the theme "Special Topics in Physical Metallurgy" provided that the number of students enrolled in course do not exceed 25.**			
Laboratory Work	none			
Computer Use				
Other Activities				

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	MIN 1	25-30
	Quizzes	MIN 4	16-30 *
	Homework		
	Projects		
	Term Paper/Project	MAX 1	0-14 *
	Laboratory Work		
	Other Activities		
	Final Exam	1	40-45
	***** Total percentage of quizzes and term project grades should not exceed 30 %. ****** This is an optional project based on the decision of the lecturer if the total number of students enrolled in the course do not exceed 25.		