Course Name						
ENGINEERING POLYMERS						
				Course Implementation, Hours/Week		
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Theoretical**	**Tutorial**	**Laboratory**
MET439E	7	2	3	2	0	0

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**
		50 %	**50 %**	
Course Description	This course aims to introduce and describe the properties of thr polymeric materials and polymer-based materials as the advanced technological materials and details the manufacturing techniques of polymer-based materials.			
Course Objectives	1. To introduce the fundamental aspects of polymerization mechanisms 2. To describe the polymer types and explain the differences between polymer classes and polymerization 3. To qualitatively explain the nature, configuration and dimension of the polymer chain, polymer branches and co polymerization 4. To express the relationship between molecular structure and the physical and mechanical properties of polymers 5. To explain phenomenological the amorphous state, the crystalline state and the elastomeric state. 6. To discuss, by means of introducing a thought experiment, four different regions of the viscoelastic behavior, the WLF negatron and the master curves for viscoelastic solids 7. To construct various analog viscoelastic models and enhance with sample problems 8. To explain polymer manufacting methods			
Course Learning Outcomes	1. Learn what polymers are, how they are made and classify them according to polymer types 2. Be able to relate the physical properties and character of a polymer and its bounding and chain structure/configuration 3. Understand the concepts of rubber elasticity and viscoelasticity model and contruct 4. Be able to analog models for the elastic, elastic-plastic, viscoelastic and creep behaviour of polymers. 5. Be able to construct a master curve for a viscoelastic and creep behaviour of polymers 6. Learn the polymer manufacturing methods and fields of application of engineering polymers.			
Textbook	• R. J. Young and P. A. Lovell, Introduction to Polymers, Chapman & Hall, London, 2nd Edition, 1991. • Fred W. Billmeyer, Jr., Textbook of Polymer Science, John Wiley & Sons, New York, 3rd Edition, 1984. • John J. Aklonis and William J. MacKnight, Introduction to Polymer Viscoelasticity, John Wiley & Sons, 2nd Edition, 1983. • M. L. Öveçoğlu, Non-metallic Materials Course Notes, 1996			
Other References				
Homework & Projects				
Laboratory Work				
Computer Use				
Other Activities				

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	**1**	**30**
	Undeclared Quizzes	**MIN 2**	**25**
	Homework		
	Projects		
	Term Paper/Project		
	Laboratory Work		
	Other Activities		
	Final Exam	**1**	**45**

COURSE PLAN

Weeks	Topics	Course Outcomes
1	Introduction. Natural polymers, natural rubber and history. Polymer classes, engineering polymers and properties. Introduction to carbon chemistry. Hydrocarbons : alkanes(paraffines), alkenes(olefines), ring groups, benzenes, functional groups.	I
2	Polymerization mechanisms : Addition and condensation polymerization. Polymerization types: Vynil, dien, ester, amine, saccharine polymerization. Thermoset resins. Copolymerization.	I
3	Functionality of monomers. Degree of polymerization. Molecular weight. Network structures. Branching and cross-linking. Vulcanization.	I, II
4	Example problems related to polymerization mechanisms, cross-linking and vulcanization. Polymer structures and crystallization. Effects of temperature and time. Symmetry and conformation. Crystalline polymer structures. Network structure : network forming and network modifying elements.	II
5	Amorphous state. The four regions of the viscoelastic behaviour. Temperature-relaxation modulus and pertinent factors. Elastomeric state. Relaxation time. Rubber elasticity.	III
6	Amorphous state. The four regions of the viscoelastic behaviour. Temperature-relaxation modulus and pertinent factors. Elastomeric state. Relaxation time. Rubber elasticity. Glass : brief introduction and descriptive analysis. Glass structure and glass forming mechanisms (II)	III
7	Viscoelastic properties of polymers. Elasticity, viscoelasticity and creep. Analog models : Maxwell, Voigt models and sample problems.	IV
8	Analog models : Maxwell, Voigt models and sample problems. Standart Lineer Solid Model. Four-element analog model. Tensile and creep properties of polymers. Sample problems.	II, IV
9	Standard Lineer Solid Model. Four-element analog model. Tensile and creep properties of polymers. Sample problems. Damping properties of polymers.	II, V
10	Damping properties of polymers. Hysteresis curves and energy losses. The torsional pendulum concept.Forming and manufacturing properties of polymers. Molding, extrusion, pressing and pultrusion. Materials used in the manufacturing of plastics.	II, V
11	Forming and manufacturing techniques of polymers. Pressing, extrusion, molding and pultrusion. Materials used in the plastics industry and their roles (I).	VI
12	Forming and manufacturing techniques of polymers. Pressing, extrusion, molding and pultrusion. Materials used in the plastics industry and their roles (II).	VI
13	Overall evaluation and fields of applications of engineering polymers - I.	VI
14	Overall evaluation and fields of applications of engineering polymers - II	VI

Relationship between the Course and Materials & Metallurgical 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)		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			x
	PROPERTIES			x
	DESIGN EXPERIMENT/ANALYSE DATA	x		
	PROCESSING			x
	COST/PERFORMANCE	x		
	QUALITY/ENVIRONMENT	x		
	DESIGN PROCESS OR PRODUCT		x	
MATERIAL CLASSES	METAL			
	CERAMICS			
	POLYMERS			x
	COMPOSITES		x	

1: Little, 2. Partial, 3. Full

Prepared by	Date	Signature
ASSOC.PROF. DR. M. Reza Nofar	December 2020	