Course Name						
ENGINEERING POLYMERS						
				Course Implementation, Hours/Week		
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Theoretical**	**Tutorial**	**Laboratory**
MET439E	7	2	3	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**
	-	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 manufacturing 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 behavior of polymers. 5. Be able to construct a master curve for a viscoelastic and creep behavior of polymers 6. Learn the polymer manufacturing methods and fields of application of engineering polymers.			
Textbook	1. N.G. McCrum & C.B. Buckley, C.B. Bucknall, Principles of Polymers Engineering, Oxford University Press, 2nd Edition, 2007 2. W.D. Callister, Materials Science & Engineering, Wiley, 9th Edition, 2014 3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press 3rd Edition, 2011. 4. Nofar, M, Multiphase Polylactide Blends: Toward a Sustainable and Green Environment. Elsevier, 2021			
Other References				
Homework & Projects				
Laboratory Work				
Computer Use				
Other Activities				

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	**2**	**25**
	Quizzes		
	Homework		
	Projects		
	Term Paper/Project		
	Laboratory Work		
	Other Activities		
	Final Exam	**1**	**50**

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.	1
2	Polymerization mechanisms : Addition and condensation polymerization. Polymerization types: Vynil, dien, ester, amine, saccharine polymerization. Thermoset resins. Copolymerization.	1
3	Functionality of monomers. Degree of polymerization. Molecular weight. Network structures. Branching and cross-linking. Vulcanization.	1,2
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.	2
5	Amorphous state. The four regions of the viscoelastic behaviour. Temperature-relaxation modulus and pertinent factors. Elastomeric state. Relaxation time. Rubber elasticity.	3
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)	3
7	Viscoelastic properties of polymers. Elasticity, viscoelasticity and creep. Analog models : Maxwell, Voigt models and sample problems.	4
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.	2,4
9	Standard Lineer Solid Model. Four-element analog model. Tensile and creep properties of polymers. Sample problems. Damping properties of polymers.	2,5
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.	2,5
11	Forming and manufacturing techniques of polymers. Pressing, extrusion, molding and pultrusion. Materials used in the plastics industry and their roles (I).	6
12	Forming and manufacturing techniques of polymers. Pressing, extrusion, molding and pultrusion. Materials used in the plastics industry and their roles (II).	6
13	Overall evaluation and fields of applications of engineering polymers - I.	6
14	Overall evaluation and fields of applications of engineering polymers - II	6

Relationship between the Course and Materials & Metallurgical Engineering Curriculum

	Student Outcomes	Level of Contribution		
		1	2	3
1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering science and mathematics			X
2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare as well as global, cultural, social, environmental and economic factors			X
3	an ability to communicate effectively with a range of audiences	X		
4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts			X
5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	X		
6	an ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgement to draw conclusions			X
7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies		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 AND GLASS			
	POLYMERS			X
	COMPOSITES		X	
	BIOMATERIALS	X		

1: Little, 2. Partial, 3. Full

Prepared by	Date	Signature
Assoc. Prof. M. Reza NOFAR	December 2020	