



## Course Syllabus: Polymers and Polymerization Processes - ChemS 215

<b>Division</b>	Physical Science and Engineering Division
<b>Course Number</b>	ChemS 215
<b>Course Title</b>	Polymers and Polymerization Processes
<b>Academic Semester</b>	Fall
<b>Academic Year</b>	2018/2019
<b>Semester Start Date</b>	08/26/2018
<b>Semester End Date</b>	12/11/2018
<b>Class Schedule</b> (Days & Time)	04:00 PM - 05:30 PM   Mon Thu

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Nikolaos Hadjichristidis	Nikolaos.Hadjichristidis@kaust.edu.sa	+966128080789	4234, 5, Al-Kindi (bldg. 5)	Sunday to Thursday from 8:30 am to 10am and by appointment.

Teaching Assistant(s)	
Name	Email
Panagiotis Bilalis	panagiotis.bilalis@kaust.edu.sa

Course Information	
<b>Comprehensive Course Description</b>	Concepts and definitions: monomers and monomeric units, degree of polymerization, homopolymers, copolymers, nomenclature and classification, chain structure, microstructure, conformation and flexibility, average molecular weights and polydispersity, thermoplastics, thermosets, elastomers, fibers, plastics; Polymerization methods: step-growth, radical, living radical, anionic, cationic, catalytic, ring opening metathesis, polyhomologation; Methods of molecular weight determination: membrane and vapor pressure osmometry, light scattering, size exclusion chromatography, viscometry; Properties: thermal, mechanical, flow; Fundamentals of polymer processing: extrusion, injection, film blowing.
<b>Course Description from Program Guide</b>	The preparation, reactions and properties of high-molecular-weight polymeric materials of both natural and synthetic origin. Physical and organic chemistry of polymers for persons with a basic training in chemistry, physics, or engineering. The course is a survey of preparative methods of polymers; step growth polymerization, radical polymerization, ionic polymerization, ring-opening polymerization, polymerization by transition metal catalysts; and methods of characterization (nuclear magnetic resonance, Raman, infrared, intrinsic viscosity, differential scanning, calorimetry, gel permeation chromatography) and scattering (light, x-rays).
<b>Goals and Objectives</b>	To be able to: a) Digest the fundamentals of polymer science; b) read and understand a scientific paper on Polymers and c) predict the properties/applications of simple polymeric materials.
<b>Required Knowledge</b>	Basic training in Chemistry, Physics or Engineering.
<b>Reference Texts</b>	Required: "Essential of Polymer Science and Engineering", P.C. Painter and M.M. Coleman Reference: 1) "Organic and Physical Chemistry of Polymers" Y. Gnanou and M. Fontanille; 2) "Polymers: Chemistry and Physics of Modern Materials", J.M.G. Cowie and V. Arrighi

<b>Method of evaluation</b>	<p>10.00% - Exam 1  10.00% - Scientific review article presentation  20.00% - Midterm exam  10.00% - Group Project(s)  40.00% - Final exam  10.00% - Exam 2</p>
<b>Nature of the assignments</b>	Paper presentation and group projects.
<b>Course Policies</b>	<p>Attendance policy: Lecture attendance is mandatory. If the student is unable to attend on the date indicated the instructor will be notified a week in advance.</p> <p>Honor Code: In accordance to the University policy and professional standards, the highest levels of academic integrity are expected in the class. The code of student conduct is strictly enforced. Academic dishonesty will result in reduction in grade and/or expulsions from this class and/or University.</p>
<b>Additional Information</b>	In the first course 10 exploratory questions are given to the students in order to evaluate their level.

## Tentative Course Schedule

*(Time, topic/emphasis & resources)*

Week	Lectures	Topic
1	Mon 08/27/2018	Concepts and definitions-1. Monomers and monomeric units, degree of polymerization, homopolymers, copolymers, nomenclature and classification.
1	Thu 08/30/2018	Concepts and definitions-2. Chain structure, microstructure, conformation and flexibility.
2	Mon 09/03/2018	Concepts and definitions-3: Average molecular weights and polydispersity, thermoplastics, thermosetting, elastomers etc.
2	Thu 09/06/2018	Step-growth polymerization-1. Classification of polymerizations, control of molecular weight in stepgrowth polymerization.
3	Mon 09/10/2018	Step-growth polymerization-2. Control of polydispersity, kinetics (rate of polymerization, average kinetic length).
3	Thu 09/13/2018	Conventional radical polymerization-1. Monomers and initiators, mechanism and kinetics.
4	Mon 09/17/2018	Conventional radical polymerization-2. Chain transfer, inhibitors and retarders.
4	Thu 09/20/2018	Test 1
5	Mon 09/24/2018	Controlled/living radical polymerization methods-1. Atom transfer radical Polymerization, ATRP.
5	Thu 09/27/2018	Controlled/living radical polymerization methods-2. Nitroxide mediated radicalpolymerization, NMP; reverse addition fragmentation transfer radical polymerization, RAFT.
6	Mon 10/01/2018	Cationic polymerization: Mechanism and kinetics.
6	Thu 10/04/2018	Anionic polymerization-1. Mechanism and kinetics, initiation, propagation, microstructure.
7	Mon 10/08/2018	Anionic polymerization-2. High vacuum techniques.
7	Thu 10/11/2018	Midterm Exam
8	Mon 10/15/2018	Catalytic polymerization. Ziegler-Natta, Metallocene.
8	Thu 10/18/2018	Ring opening metathesis polymerization. Monomers, initiators, kinetics.
9	Mon 10/22/2018	Polyhomologation. Polymerization of ylides, synthesis of polyethylene=based polymers and copolymers.
9	Thu 10/25/2018	Macromolecular engineering-1. Synthesis of well-defined linear, star and comb polymers by combination of different polymerization methods.
10	Mon 10/29/2018	Macromolecular engineering-2. Synthesis of cyclic, block-graft, star-graft and dendritic polymers by combination of different polymerization methods.
10	Thu 11/01/2018	Macromolecular engineering-2. Synthesis of cyclic, block-graft, star-graft and dendritic polymers by combination of different polymerization methods.
11	Mon 11/05/2018	Exam 2

11	Thu 11/08/2018	Methods of molecular weight determination-1. Vapor pressure osmometry, principle and experimental methods.
12	Mon 11/12/2018	Methods of molecular weight determination-2. Membrane osmometry, principle and experiment.
12	Thu 11/15/2018	Methods of molecular weight determination-3. Static and dynamic light scattering, principle and experiment.
13	Mon 11/19/2018	Methods of molecular weight determination-4. Viscometry and gel permeation chromatography, principle and experiment.
13	Thu 11/22/2018	Properties in bulk. Mechanical, thermal, morphological.
14	Mon 11/26/2018	Fundamentals of processing-1. Extrusion, injection.
14	Thu 11/29/2018	Fundamentals of processing-2. Film blowing.
15	Mon 12/03/2018	Scientific review article presentation
15	Thu 12/06/2018	Group Project
16	Mon 12/10/2018	Final Exam

**Note**

The instructor reserves the right to make changes to this syllabus as necessary.