



## 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>	2019/2020
<b>Semester Start Date</b>	08/25/2019
<b>Semester End Date</b>	12/10/2019
<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>	10.00% - Exam 2 40.00% - Final exam 10.00% - Group Project(s) 20.00% - Midterm exam 10.00% - Scientific review article presentation 10.00% - Exam 1
<b>Nature of the assignments</b>	Paper presentation and group projects.
<b>Course Policies</b>	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. 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.
<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 08/26/2019	<b>Concepts and definitions-1.</b> Monomers and monomeric units, degree of polymerization, homopolymers, copolymers, nomenclature and classification.
1	Thu 08/29/2019	<b>Concepts and definitions-2.</b> Chain structure, microstructure, conformation and flexibility. Size and shape of flexible chains.
2	Mon 09/02/2019	<b>Concepts and definitions-3:</b> Average molecular weights and polydispersity, thermoplastics, thermosettings, elastomers, thermoplastic elastomers..
2	Thu 09/05/2019	<b>Step-growth polymerization-1.</b> Control of molecular weight and molecular weight distribution.
3	Mon 09/09/2019	<b>Step-growth polymerization-2.</b> Kinetics. Industrial polymerization methods
3	Thu 09/12/2019	<b>Conventional radical polymerization-1.</b> Monomers and initiators, mechanism and kinetics.
4	Mon 09/16/2019	<b>Conventional radical polymerization-2.</b> Chain transfer, inhibitors and retarders.
4	Thu 09/19/2019	<b>Conventional radical polymerization-3.</b> Industrial polymerization methods (bulk, solution, suspension, emulsion)
5	Mon 09/23/2019	<b>Saudi National Day.</b>
5	Thu 09/26/2019	<b>Test 1.</b>
6	Mon 09/30/2019	<b>Controlled/living radical polymerization methods-1.</b> Nitroxide mediated radical polymerization (NMP). Mechanism, macromolecular architecture.
6	Thu 10/03/2019	<b>Controlled/living radical polymerization methods-2.</b> Atom transfer radical polymerization (ATRP). Mechanism, macromolecular architecture.
7	Mon 10/07/2019	<b>Controlled/living polymerization-3.</b> Reverse addition fragmentation transfer radical polymerization (RAFT). Mechanism, macromolecular architecture.
7	Thu 10/10/2019	<b>Cationic Polymerization.</b> Mechanism and kinetics.
8	Mon 10/14/2019	<b>Mid-term exams.</b>
8	Thu 10/17/2019	<b>Anionic polymerizaion-1.</b> Monomers, initiators, solvents. Mechanism and kinetics.
9	Mon 10/21/2019	<b>Anionic Polymerization-2.</b> Control of molecular weight, structure and microstructure.
9	Thu 10/24/2019	<b>Anionic polymerization-3.</b> High-vacuum techniques. Macromolecular engineering. Synthesis of well-defined linear, star, comb, cyclic, block-graft, star-graft and dendritic polymers.
10	Mon 10/28/2019	<b>Mid-semester break.</b>
10	Thu 10/31/2019	<b>Copolymerization.</b> Basics, kinetics, reactivity ratios. Random, alternating, tapered and block copolymers.

11	Mon 11/04/2019	<b>Catalytic polymerization.</b> Ziegler-Natta and Metallocene.
11	Thu 11/07/2019	<b>Ring-opening polymerization.</b> Catalysts, initiators, mechanism and kinetics.
12	Mon 11/11/2019	<b>Polyhomologation or C1 polymerization.</b> Ylide monomers, initiators, synthesis of polyethylene-based polymeric materials.
12	Thu 11/14/2019	<b>Test 2.</b>
13	Mon 11/18/2019	<b>Methods of molecular weight determination-1.</b> Gel permeation chromatography, viscometry.
13	Thu 11/21/2019	<b>Methods of molecular weight determination-2.</b> Membrane and vapor pressure osmometry.
14	Mon 11/25/2019	<b>Methods of molecular weight determination-3.</b> Static and dynamic light scattering.
14	Thu 11/28/2019	<b>Properties of polymers in bulk.</b> Morphological, mechanical, thermal, flow.
15	Mon 12/02/2019	<b>Fundamentals of processing.</b> Extrusion, injection, film blowing.
15	Thu 12/05/2019	<b>Paper and group project presentations.</b>
16	Mon 12/09/2019	<b>Final exams.</b>

### Note

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