COURSE ID SHEET

Course No.	5154	NTUA

Semester:	9	Core		Elective		Specialization	X

TITLE	**Polymer Production Engineering**

AIM	The aim of the course is to extend the knowledge of the student on the polymerization processes, including recycling and upcycling approaches. At the end of the course, the student should be able to: i) define the appropriate polymerization mechanism and technique for a given monomer, ii) understand the relationships between polymerization parameters and polymer properties, iii) calculate the molecular weight of a polymer based on the most common relevant characterization techniques, iv) describe quantitatively basic polymerization processes, v) describe alternative polymerization techniques for the production of environmentally friendly polymers, vi) suggest recycling technologies for different types of plastic waste.

CONTENT

- **INTRODUCTION**. Classification of polymers. Molecular weight distribution and averages. Common molecular weight characterization methods.
- **STEP-GROWTH POLYMERIZATION**. Linear and non-linear step-growth polymerization. Reaction rate expressions and experimental study of polymerization systems. Production of biodegradable and/or bio-based polymers. High performance polymers.
- **CHAIN-GROWTH POLYMERIZATION**. Free-radical polymerization processes. Reaction rate expressions. Autoacceleration.
- **POLYMERIZATION TECHNIQUES**. Industrial scale polymerization processes. Reactor engineering and polymerization modelling. *In situ* polymerization processes for the production of advanced materials (nanocomposites, encapsulation systems)
- **ENVIRONMENTALLY FRIENDLY POLYMERIZATION TECHNIQUES**. Solid state polymerization. Enzymatic polymerization.
- **PLASTIC RECYCLING AND WASTE MANAGEMENT**. Polymers auto-oxidation and photo-oxidation cycles. Stabilization. Recycling and upcycling technologies.

Lab Outline: Step-growth polymerization: Polyamide salts preparation and interfacial polymerization; **Chain-growth polymerization:** Polymerization and characterization of poly(methyl methacrylate); **Solid state polymerization**: Determination of process conditions via thermal analysis; **Post-polymerization:** Crosslinking of unsaturated polyester; **Biodegradable polymers**: Hydrolytic degradation and stabilization of poly(lactic acid); **Polymer recycling**: Selective dissolution-reprecipitation technique. Remelting-restabilization technique; **Product design:** *In situ* polymerization for the preparation of polymeric microcapsules. Application in self-healing systems.

HOURS PER SEMESTER

LECTURE	**24**	EXERCISES	-	LABORA-TORY	**16**	HOME-WORK	**135**	**TOTAL HOURS: 175**

STUDENT PERFORMANCE

The learning outcomes are assessed through a **written exam (E)** (according to the program of the School, as an open book test), **Laboratory practice (LP)** and through an optional literature-based project, where a **written report (R)** is submitted and graded.
The final grade results as follows:

EVALUATION	**Final Grade = (E) x 0.4 + (LP) x 0.4 + (R) x 0.2** or **Final Grade = (E) x 0.6 + (LP) x 0.4** Prerequisite: E ≥ 5