ENMA 423: Manufacturing With Polymers (Elective) – 3 credits

Class Schedule: Tuesday/Thursday, 3:30pm-4:45, CHE 2118

Instructor: Dr. R.M. Briber

Textbook: no required text, class notes and research projects will be the focus of the course

Catalog Description: Study of the process of engineering design and development of polymer formulations. Knowledge of commodity polymers and their physical properties, ability to design an extrusion process, develop the economics of a polymer manufacturing process, develop a working knowledge of characterization techniques for determination of physical and mechanical properties of polymers.

Course Description: This course introduces students to the broad spectrum of issues associated with the use, manufacturing and processing of polymers, which includes addressing issues of blending of materials, design and production of a polymer formulation and the characterization of material properties. The participants of the course will be organized into teams to work for a semester on an open ended design problem of producing and characterizing a polymer formulation for advanced materials use.

Prerequisites: ENMA 300 or permission of Department

Course Goals: The goal of this course is to introduce engineering students to the process of engineering design and development of polymer formulations. The students will gain experience in working on interdisciplinary teams with a focus on both the engineering design issues and the economics involved with process development in polymers. After satisfactory completion of this course the student should attained the following skills:

1.) General knowledge of commodity polymers and their physical properties. This includes the fundamentals of structure-property relations in polymers.

2.) The ability to design an extrusion process, including machine selection, screw design and operating conditions.

3.) Develop economics of the manufacturing process of a polymer formulation.

4.) Have a working knowledge of basic characterization techniques for determination of physical and mechanical properties of polymers.

5.) Gain significant experience with the preparation and presentation of progress reports. Oral and written communication skills are emphasized.

Student Outcomes Covered by the Course:
ABET A: Ability to apply mathematics, science and engineering principles;
ABET B: Ability to design and conduct experiments, analyze and interpret data.
ABET C: Ability to design a system, component, or process to meet desired needs.
ABET D: Ability to function on multidisciplinary teams.
ABET E: Ability to identify, formulate and solve engineering problems.
ABET G: Ability to communicate effectively;
ABET I: Recognition of the need for and an ability to engage in life-long learning;
ABET J: Knowledge of contemporary issues
ABET K: Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Topics Covered:
Introduction to Polymers
  Types of polymers
    Synthetic vs. Biopolymers
    Chain architecture and copolymers
    Commodity polymer and specialty polymers
    Basic physical properties of commodity polymers
    Recycling issues with polymers
  Fillers used with polymers
    Types of fillers
    Economics of fillers
  Blending of polymers
    Multicomponent polymer systems
    Block copolymers
    Thermodynamics of polymer blending
  Introduction to crystallization of polymers
Polymer Manufacturing
  Types of polymer processing equipment
  Introduction to polymer extrusion
  Types of extruders
  Types of extruder screw elements
  Design of extruder screws for processing
  Design and selection of extruder operating conditions for an extrusion process
Injection Molding
  Principles of injection molding
  Injection molding cycle and process design
Introduction of Polymer Flow Behavior
  Properties of viscoelastic fluids
  Mixing of fluids and solids
  Dispersive versus distributive mixing
Polymer Characterization
  Mechanical properties of polymers
  Modulus, failure stress and strain, toughness, impact properties
  Morphological characterization
    Optical microscopy
    Scanning electron microscopy