

Mechanical Engineering Department
ME-470 ENGINEERING PROPERTIES OF PLASTICS
(Elective)

Catalog Data: **ME-470 (3-0-3)**

Students will learn the unique properties of the various commercial thermosetting and thermoplastic resins. An introduction to viscoelastic theory and its relationship to measurable properties of plastics. Other engineering properties such as fatigue resistance, flammability, chemical resistance, and electrical properties will be presented. Material selection procedure for design of plastic products will also be presented

Prerequisites ME 215 - Strength of Materials
MECH 237 - Engineering Materials and Processes

Textbook: Principles of Polymer Engineering, N.G. McCrum, C.P. Buckley and C.B. Bucknall, Hanser Publishers, New York, 1997.

Supplement Plastics Handbook, edited by Modern Plastics: McGraw-Hill, Inc.

Reference Books

Mechanical Properties of Polymer and Composites, L.E. Nielsen and R.F. Landel, Marcel Dekker, Inc.

Plastics Product Design and Process Engineering, Harold Belofsky, Hanser/Gardner, (1995)

Polymeric Materials and Processing: Plastics, Elastomers and Composites, Jean-Michel Charrier, Hanser Publishers (1990).

Course Supervisor: **Kwabena A. Narh**, Associate Professor of M.E and Co-Director of the Plastics Processing Laboratory.

Prerequisites by Topic:

1. Statics
2. Tensile and Shear Properties
3. Material Structure
4. Molecular Weight
5. Elementary Design Principles

Course Objectives¹:

Objective 1. To provide students with a background in plastics (A, B, C).

Objective 2. Students will learn the unique properties of plastics (A, B, C, D)

Objective 3. Students will learn material selection procedure for design of plastic products (A, B, C, D, E).

Objective 4. Students will become familiar with the design and application of plastic products (A, B, C, D, E).

Objective 5. Students will learn the basic concepts of CAE to design and simulate mold cavity flow of plastic melts (A, B, C, D, E).

Topics² :

1. Introduction to Plastics: classification of plastics - commodity, engineering, specialty. Mechanical Properties of Plastics (4 hours)
2. Molecular weight and Molecular weight distribution -measure and statistical analysis (3 hours)
3. Physical Properties - density, viscosity, effect temperature and pressure (3 hours)
4. Viscoelasticity - physical models, mathematical models, constitutive equations, application to real situations, stress relaxation, shear recovery, relevance to design (4 hours).
5. Mechanical Properties of Plastics - tensile, flexural, compressive, shear, impact, fatigue, creep, complex, strengths and moduli, measurement and test methods, relevance of data to design, effect of temperature (5 hours).
6. Electrical Properties - comparative tracking index, dielectric strength, arc resistance measurement and test methods (3 hours).
7. Thermal properties - specific heats, thermal conductivity and diffusivity, measurement, differential scanning calorimetry (DSC) (3 hour)
8. Environmental testing: weathering, chemically aggressive environment, Flammability & Combustion (3 hours).
9. Additives - effect on properties. Alloys - synergisms. Composites - reinforcing fibers, orientations, anisotropy, laminates (3 hours)
10. Materials Selection: Properties for Design (3 hours)
11. Design Project (12 hours)

Evaluation Method:

1. Quizzes
2. Exam
3. Homework
4. Project

Schedule: Lecture Recitation: 3 hours, per week

Professional Component: Engineering Materials

Program Objectives Addressed: A, B, C, D, E

Course Outcomes³ :**Objective 1.**

1.1 Students will be able to identify different classes of plastics for engineering purposes (1,2) (a).

Objective 2.

2.1 Students will be able to identify specific plastics properties for design purposes (1,2,3) (a,b,e).

Objective 3.

3.1 Students will be able to use polymer handbooks, manufacturers' website, etc in finding plastics properties (1,2,3,4) (a,b,e).

3.2 Students will be able to identify which property factor must be considered for a specific product (1,12,3,4) (c,e,k).

Objective 4.

4.1 Students will be able to identify specific plastics properties with the products (1,2,3,4,5) (a,b,c,k).

4.2 Students will be able to associate environmental conditions with plastic products (3,4) (f,h,j).

4.3 Students will become conscious of the effects of plastics waste streams on environment (2,3,4) (f,h,j).

Objective 5.

5.1 Students will be able to perform productivity analysis, for troubleshooting the manufacturing process (1,2,3,4,5) (b,c,d,gk)

Prepared by: Kwabena A. Narh

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¹ Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering

Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

² Topic numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

³ Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.