

University of Ruhuna- Faculty of Technology
Bachelor of Engineering Technology Honours Degree
Level 4 (Semester I) Examination, June/July 2023
Academic year 2021/2022

Course Unit: ENT 4162- Polymer Materials (Written)

Duration: 2 hours



- Answer all **five (05)** questions.
 - All questions carry equal marks. The maximum marks attainable for the parts of the questions are indicated in brackets.
1. Polymers include commonly used plastic and rubber materials. Many of them are organic molecules made of chemically based on carbon, hydrogen, and other nonmetallic elements. Furthermore, they have very large molecular structures, often chain-like in nature, that often have a backbone of carbon atoms.
- a) Define the following terms.
- i) Polymer
 - ii) Monomer
 - iii) Polymerization
 - iv) Degree of polymerization
- (04 marks)
- b) Draw the monomer, the repeating unit, and the polymer structure of the following commonly used polymers.
- i) Polyvinyl chloride (PVC)
 - ii) Polystyrene (PS)
 - iii) Polytetrafluoroethylene (PTFE)
 - iv) Poly(methyl methacrylate) (PMMA)
- (06 marks)
- c) What are the four (4) classes of copolymers? Explain using appropriate drawings.
- (06 marks)
- d) Compare bulk polymerization and solution polymerization techniques using four (4) differences.
- (04 marks)

2.

a) Define the following terms.

- i) Ductility
- ii) Hardness
- iii) Impact strength
- iv) Fatigue strength
- v) Tear Strength

(05 marks)

b) In polyvinyl chloride (PVC) industry dioctyl phthalate (DOP) is added as a plasticizer. DOP makes PVC more flexible and bendable. Briefly explain this phenomenon referring to the concept of glass transition temperature.

(02 marks)

c) What is the main difference between a polymer blend and a polymer composite?

(02 marks)

d) State and define the terms of the Helmholtz free energy equation. Describe the requirement to be fulfilled for two polymers to be blended, using the equation.

(06 marks)

e) Ultrahigh Molecular Weight Polyethylene (UHMWPE) is used to manufacture "bullet-proof vests" which is an item of body armor used in military applications. Describe the properties of UHMWPE, which makes it a suitable material for such applications.

(05 marks)

3. Rubber industry is one of the most emerging industries in Sri Lanka. Rubber compounding is the key step of rubber product manufacturing process.

a) Write down two (2) reasons why rubber compounding is necessary.

(02 marks)

b) Briefly explain the function of following compounding ingredients

- i) Accelerators
- ii) Vulcanizing Agents
- iii) Flame Retardants

(06 marks)

c) Explain two (2) benefits of internal mixer compared to the two-roll mill.

(06 marks)

d) Calendaring is one of the widely used shaping operations in rubber industry. To obtain a rubber sheet with uniform thickness, which calendaring operation is preferred? Explain two main reasons behind your selection.

(06 marks)

4. Injection molding is one of the processing techniques for converting thermoplastics, and recently, thermosetting materials, from the pellet or powder form into a variety of useful products. Extrusion is a processing technique for converting thermoplastic materials in powdered or granular form into a continuous uniform melt, which is shaped into items of uniform cross-sectional area by forcing it through a die.

a) Write down the name of labeled elements of injection molding machine. Each element is labeled A to J as shown in figure 01. (05 marks)

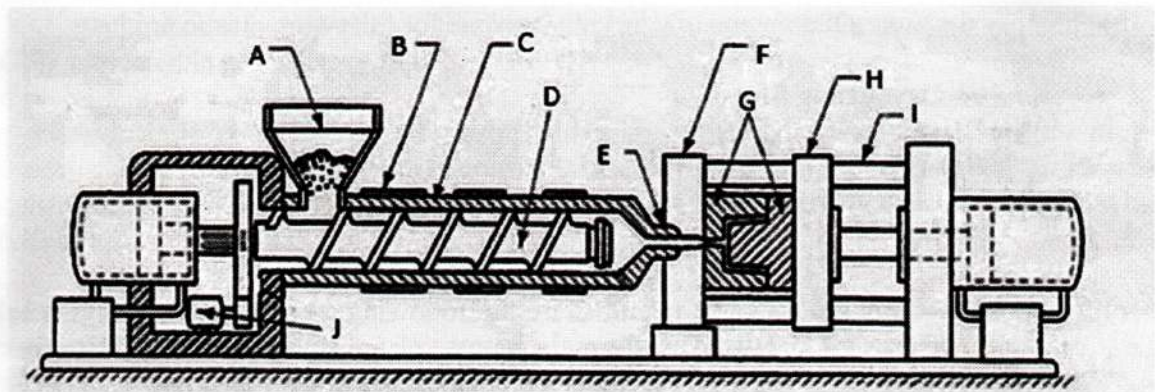


Figure 01: Elements of injection molding machine

b) Write down the operating sequence (process steps) of injection molding. (03 marks)

c) Extruder screw has basically three different zones. Mention those three zones and briefly explain the importance and features of each of those zones using suitable diagrams. (06 marks)

d) There are common injection moulding faults during production. A few of them list below according to your knowledge identify one (1) possible cause and suggest one (1) remedial action you can take to avoid it.

Faults	Possible causes	Remedial action
i) Flashing at mould		
ii) Voids		
iii) Weld lines		

(06 marks)

5. Different manufacturing processes as well as polymer materials are available for polymer product manufacturing. When selecting a manufacturing process or proper materials to manufacture a polymer product, it needs an extensive amount of thought in different aspects.

a) i) List three types of blow moulding techniques.

(03 marks)

ii) Write down four (4) process parameters of film blowing technique.

(04 marks)

b) Identify the most suitable manufacturing technique for following plastic products.

(05 marks)

- i) Food wrapping films
- ii) Garden hoses
- iii) Chairs
- iv) Microwave containers
- v) Barrels

c) Suppose that you are asked to manufacture the following plastic products. When selecting suitable materials for that, what are the main factors you are going to consider? Briefly explain two factors each giving proper reasons.

(04 marks)

- i) Single-use plastic spoon
- ii) Garden furniture

d) Buring plastic is extremely dangerous due to emission of toxic gases which can cause adverse health and environmental impacts.

i) Write down two harmful gases that can be emitted during plastic burning.

(02 marks)

ii) List down two (2) adverse health impacts of plastic burning.

(02 marks)

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