Model answer for
Polymer Midterm Exam July. 2018

Q1.

a- physical structures
* Linear polymer * Cross-Linked ply * Branched-chain

chemical structures (on the basis of functionality)
* monofunctional * Bifunctional * Trifunctional

b- preparation method
* Condensation polymerization method
* ~~Condensation~~
* Addition
  * Bulk polymerization
  * Solution
  * suspension
  * Emulsion
    Homogeneous
    Heterogeneous

c- physical properties
* Thermoplastic
* Elastomers
* Thermoset
* fibers

by origin < Natural poly.
Semimodified poly
Synthetic poly.

2- 6 p's to design polymer product
1- polymer :- properties of polymer
additive and fiber
2- process :- Extrusion, injection, compression
Heating, Mixing, Pumping, forming
morphology, orientation, Degradation.
3- product :- film // fiber, pellet, Component
4- Performance : Thermal, mechanical, optical.

5- profit: Material Cost, Die and mold Cost
machine and Energy Cost, labor and automation Cost

6 - post - Consumer Life.
recycling, Environment, substainability, Regulation
Legislation.

3 - polymer available to The designer

1- Engineering plastic: substituted for metals
such as Aluminium

2- Thermo sets: high temperature Engineering plastics
used in electronic industry

3 - Composites
Both Thermoplastic and Thermoset can reap The
benefits of fiber reinforcement.
e.g Gloss fibers are principle form of reinforcement

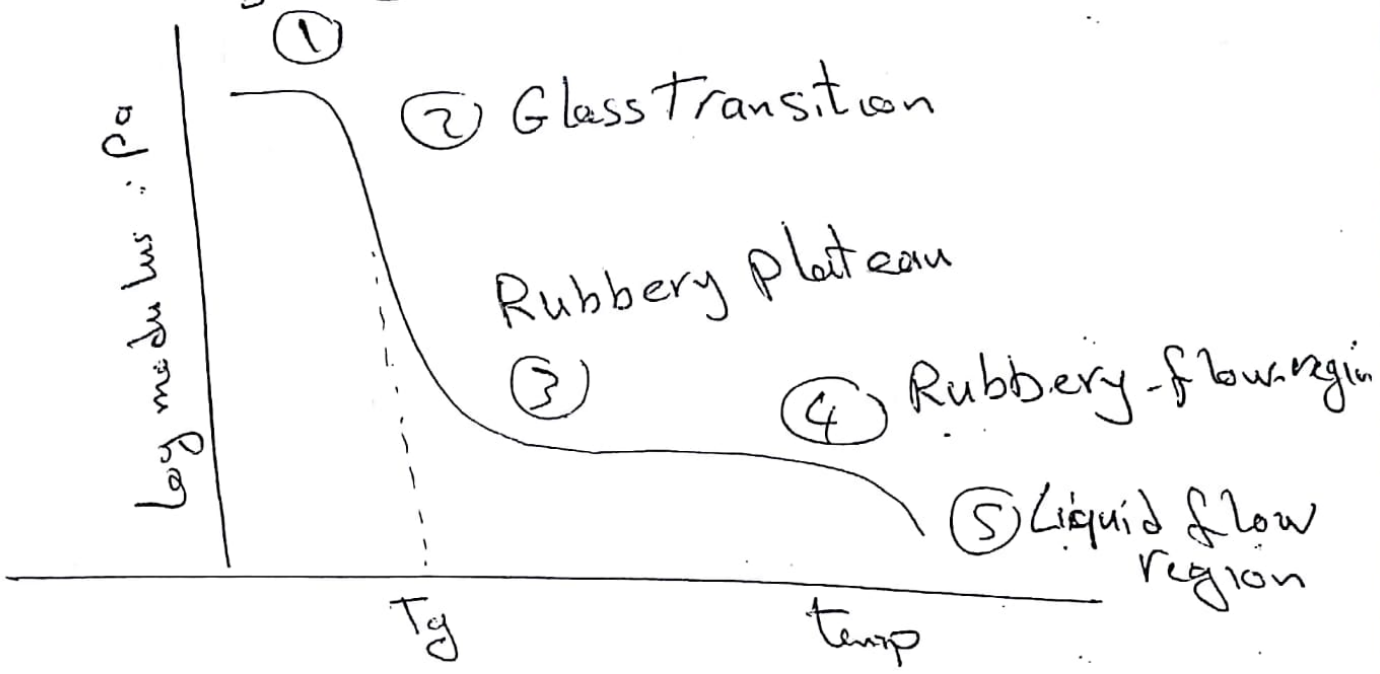
4 - structural foam
many polymers can be foamed by introduction of
blowing agent

5 - Elastomers: polymer family Consist of long chain
~~Consist~~ molecules

6 - polymer Alloys
Similar to That of Alloying metals

7 - Liquid crystal polymers.
outstanding dimensional stability.
high strength, stiffness and ease of processing

Q.2) 1. flow Curve Concept. (Modulus vs temp.



① Glassy region
- The polymer is glassy and Brittle.
- Below Tg The modulus approximately 1 GPa
- Molecular motion are restricted to vibrations and short range rotational motions

② Glass transition
- Typically The modulus drops a factor of about 1000 across a 20 - 30 C° range

③ Rubbery plateau
- Results from The formation of Entanglements in high M.W
- Modulus is inversely proportional to the M.W between entanglements Me.

④ Rubbery-flow-region
- Combines The rubber elasticity and flow properties.
- Depends on The time-Scale of experiment.
- Does not occur for cross-Linked materials

⑤ Liquid flow region - polymer flows readily

Q.2

2. chemical additive used in polymer

1- Antistatic agent :- to improve surface and conductivity and reduce the tikelihood of sport or discharge

2- Coupling agents: to improve the bonding of the polymer to inorganic filler

3- fillers: to improve the mechanical properties to reduce cost.

4- flame retardants :- to ~~improve~~ reduce the combustio of polymer.

5- lubricants :- to improve the viscosity of the molten polymer and improve forming characterisli e.g. wax or calcium stearate

6- pigments :- to ~~im~~produce colours in plastics.

7- plasticisers: to alter the properties and forming characteristics

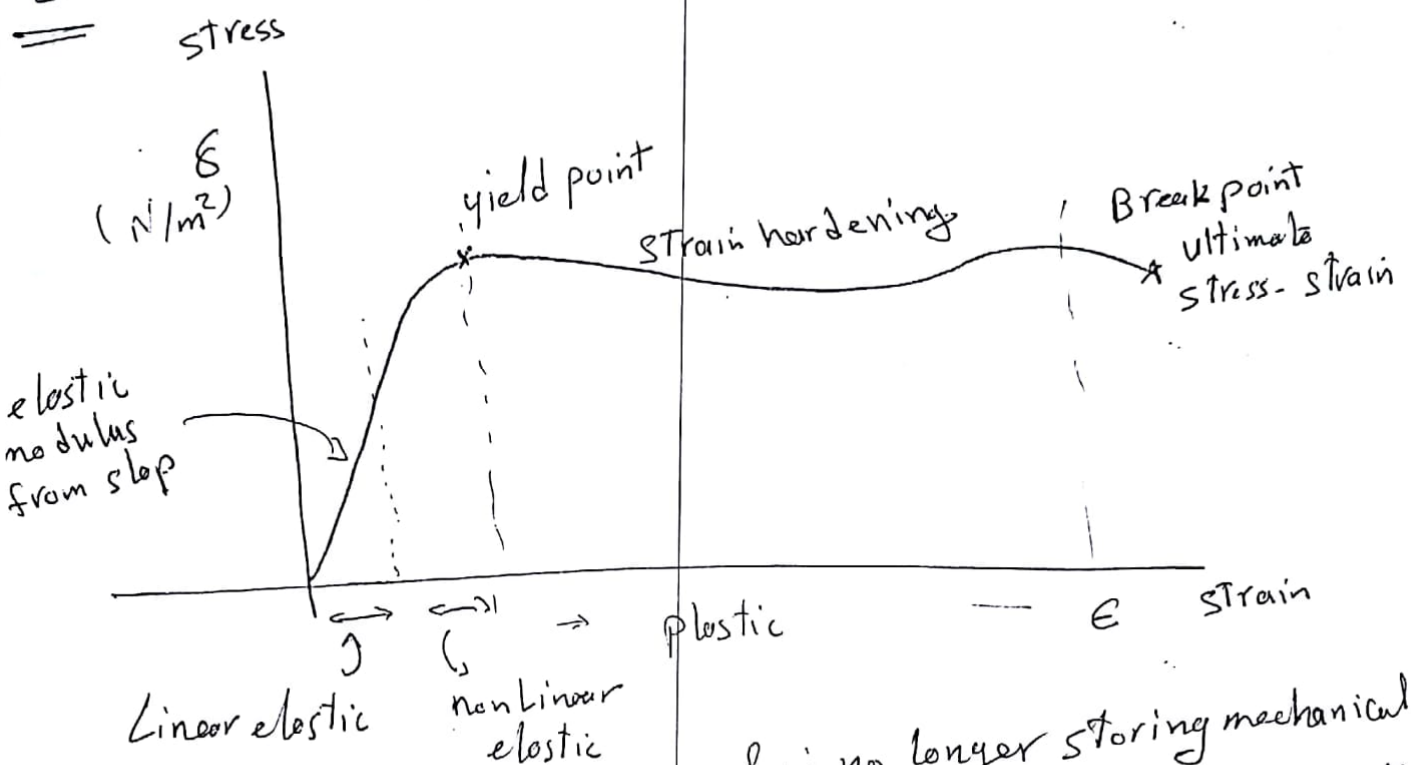
8- Reinforcement :- to improve the strength and stiffness of polymer

9- stabilisers :- to ~~im~~prevent deterioration of the Polymer due to invironmental factors

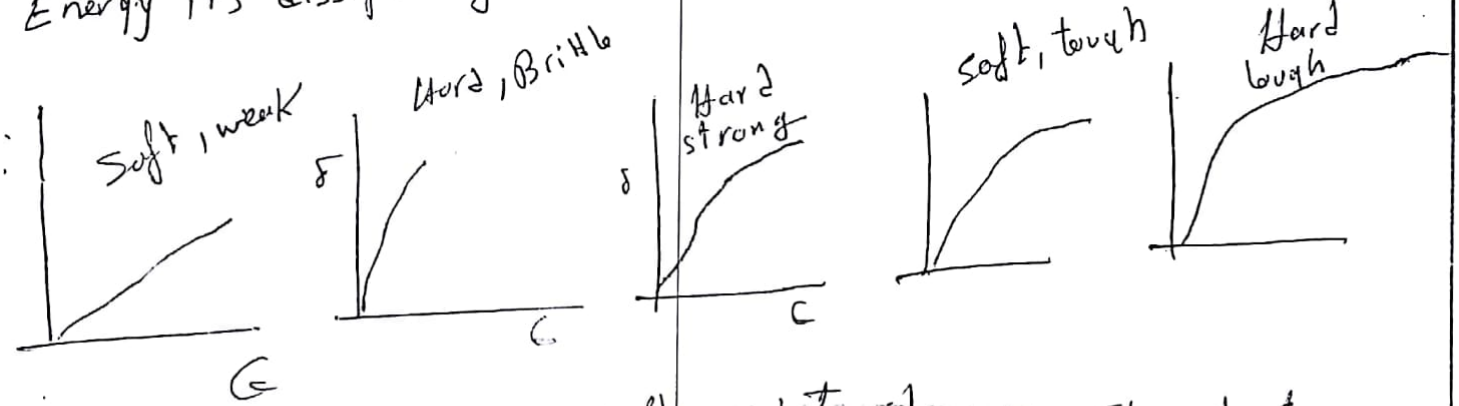
Question 3

3-

Stress-strain curve



yield point :- mean That The material is no longer storing mechanical Energy it's dissipating mechanical energy by deforming permanently



Material	Elastic modulus	yield point	tensile strength	Elongat at Break
B) Soft - weak	low	low	low	moderate
E) Hard, Brittle	High	non existant	High	Low
5) Hard, strong	High	high	high	moderate
5) Soft, tough (Rubber)	low	low	moderate	High
5) Hard, tough nylon, Cellulose acetate	High	High	High	High

Question 3

1 Types of mechanical test

* static testing :- tensile, compressive and shear properties stress-strain curve, stiffness, strength and toughness
* impact test :- high strain-rate properties :- impact strength
* creep test time dependence of elongation; viscoelasticity
* Dynamic (Mechanical) viscoelastic properties, Thermal transition, molecular relaxation
* fatique test : Life time or durability.
* Hardness resistance to surface indentation
* abrasion resistance weight loss by abrader or finely divided abrasive

2 Rheology study of the flow / deformation behaviour of material both in liquid and solid state

- Elasticity The ability to undergo reversible deformation or carry a stress without suffering permenant deformation
- strength The ability to sustain a dead load

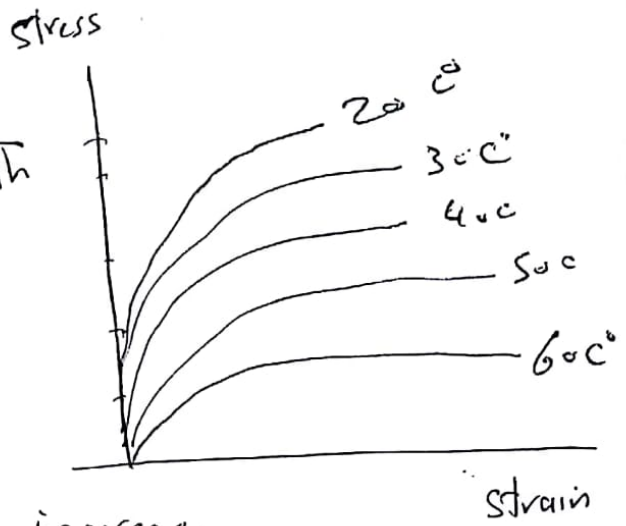
toughness : The energy spent in causing a material to fail. in the tensile test. The area under the stress-strain curve represent a measure of toughness

Question 3 (4)

1- temp ↑

↓ inelastic modulus

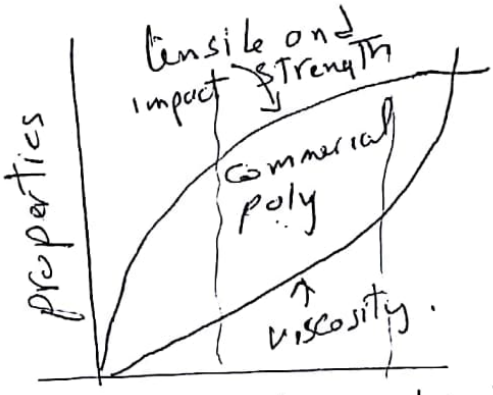
- reduction in tensile strength
- Enhancement of ductility



2- Molecular wieght M.W

↑ tensile & impact strength increase with increasing M.w due to increase chain entanglements

↑ viscosity increase



3- Degree of crystallinity

↑ crystallinity _ ↑ density, higher resistance to both dissolution and softening by heat