Polymeric Materials **Midterm Exam** **23 Oct 2019**

Each question is worth of 4 points, unless otherwise noted.
Keep your answer as brief as possible.

1. Since polymers are polydisperse, molecular weight [MW] should be expressed as the averages.
   (a) Define number-average MW Mn, weight-average MW Mw, and polydispersity index PDI. Use N for the number of molecules and M for MW.
   (b) Although viscosity-average MW Mv is conveniently and vastly used, it is not an absolute MW average like Mn or Mw. Why is that, and how is Mv related to Mn or Mw?
   (c) Name one experimental or instrumental method for determining each of Mn, Mw, PDI, and Mv. No need to explain, just name them.
   (d) PDI of the polymers prepared by radical chian and ionic chain polymerzation is typically larger and smaller, respectively, than that of step polymers. Explain why.

2. For the realxation behavior of polymers, answer the following questions
   (a) Construct the plot of log E versus temperature of (amorphous) polystyrene [PS] with the Tg of 100 ºC. E = Young's modulus in Pa. Pa = Pascal = 10 dyne/cm^2. Temperature range from 25 ºC to 300 ºC.
   (b) On your plot of (a), add the tan δ curve. How is tan δ recorded?
   (c) On your plot of (a), add the curve for the (semi)crystalline PS. How would you obtain crystalline PS?
   (d) On your plot of (a), add the curve for the crosslinked PS. How would you obtain crosslinked PS?

3. Answer the following questions briefly.
   (a) How is a block copolymer different from a graft copolymer?
   (b) How is emulsion polymerization different from suspension polymerization?
   (c) How is a thermally stable polymer different from a heat resistant polymer?
   (d) How is Me different from Mc of an amorphous polymer?
   (e) How are the structure and properties of thermoplastics different from those of thermosets?
   (f) How is a primary antioxidant different from a secondary antioxidant?
   (g) How is a primary plasticizer different from a secondary plasticizer?
   (h) How is ductility of a material different from toughness?
   (i) How is viscoelastic behavior different from non-linear mechanical behavior?
   (j) How is Boltzmann superposition different from time-temperature superposition?
   (k) How is Newtonian behavior of fluid is different from Troutonian?
   (l) How is sandwich molding different from structural injection molding?
   (m) How is extrusion blow molding different from injection blow molding?

4. [8 x 2 points] Fill the blanks.
When a polymer specimen is subjected to a stress exceeding its (visco)elastic limit, it experiences either of (a)_____ or (b)_____; (a) leads to the ductile failure and (b) to brittle fracture.
Before ductile failure, the polymer go through (c)_____, which consists of (d)_____ and (e)_____ following (d).
The reason why brittle fracture occurs at a stress much lower than rhe theoretical strength, which is about (f)_____ of its modulus, is the existence of flaw like crack, inclusion, or notch. (g)_____ and (h)_____ in front of cack tip limit (a) of material and lead to brittle fracture.