Assignment: 3

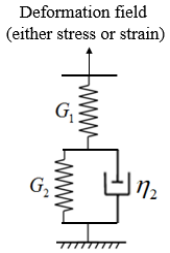
1. A polymer-nanocomposite when subjected to a step strain, the relaxation modulus shows two step exponential increase with an equilibrium modulus value, Answer the following:

a) Suggest a mechanical model (consist of spring and dashpot elements), which can capture the above mentioned experimental behaviour.

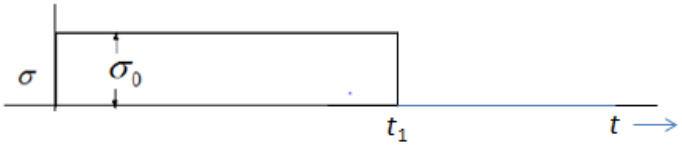
b) Derive the constitutive equation for the above proposed mechanical model. (assume your own model parameters)

c) Solve your proposed mechanical model for step strain test and show that relaxation modulus indeed show shows two step exponential decay with an equilibrium modulus

2. Consider a mechanistic rheological model shown in the figure below.



The above model has been sujcted to the constant stress (within linear regime) up to time t_1, after which stress has been removed, as shown in figure below.



Upon the removal of stress some part of strain recovers instanaly (known as instantaneous elastic recovery), followed by sluggish decrease in strain as time progresses.

a) Find out the expression of strain rate as a function of time during creep step.

b) plot the approximate time-evolution of strain during creep as well as recovery step, and mark instantaneous elastic strain (at the start of creep) and instantaneous elastic recovery in your plot.

c) Find out the expression for strain as a function of time during recovery step excluding instantaneous elastic recovery).

3. Consider a polymeric solution undergoing crosslinking reaction, which leads to a formation of three dimensional networks (spanning the whole material) due to cross-links formation between various polymer molecules. Such **three dimensional network is generally known as GEL**. Let's say that the rate of cross-linking reaction increases with increase in temperature.

You have taken 5 batches (B1, B2, B3, B4, B5 all identical in chemical composition in the beginning) of a polymer solution, which undergo cross-linking reaction at 5 different temperatures, $T_1 < T_2 < T_3 < T_4 < T_5$ respectively for the same duration, after which reaction has been terminated and we have finally 5 gel products (G1, G2, G3, G4, G5) of different cross-linking density. Answer the following:

a) Plot the creep compliance as a function of time for each gel product qualitatively on the same plot, showing the right order of creep-compliance curves.

b) Plot the relaxation modulus decay curve for each gel product qualitatively on the same plot, showing the right order of curves.

c) Which gel will show highest relaxation time scale and why?