

Homework 4

CM4650

Spring 2020

Due: *Wednesday 4 March 2020, in class*

Please do not write on the back side of the pages. Please write legibly and large. Thank you.

1. (30 points) Please answer in your own words (i.e. don't quote me directly in your answer; don't quote the internet).
 - a. Give an example of a fluid exhibiting a memory effect. Explain why we use the word “memory” to describe this kind of behavior.
 - b. Many materials exhibit “rate-dependent effects” in their rheological response. Give an example of such an effect.
 - c. Why are memory and rate-dependent effects interesting or important?
2. (20 points)
 - a. What are the “*rate-based*” material functions in shear? In elongation?
 - b. What are the “*strain-based*” material functions in shear? In elongation?
3. (10 points)
 - a. For *general* shear flow, derive the rate-of-deformation tensor $\underline{\dot{\gamma}}$. What does the rate-of-deformation tensor become for *steady* shear flow?
 - b. Derive the magnitude of the rate-of-deformation tensor for steady shear flow.
4. (10 points)
 - a. For *general* uniaxial elongational flow, derive the rate-of-deformation tensor $\underline{\dot{\gamma}}$. What does the rate-of-deformation tensor become for steady uniaxial elongational flow?
 - b. Derive the magnitude of the rate-of-deformation tensor for steady uniaxial elongational flow.
5. (20 points) Calculate the shear strain $\gamma_{21}(t_{ref}, t)$ for the flows associated with the following material functions:
 - a. Steady shear, use $t_{ref} = 0$
 - b. Start-up of steady shear, use $t_{ref} = -\infty$