

# Homework 4

## CM4650

### Spring 2018

Due: *Wednesday 7 March 2018, 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. What does it mean for a fluid to show "*memory effects*?" Give an example of a memory effect.
  - b. What does it mean for a fluid to exhibit a "*rate-dependent effect*?" Give an example of a rate-dependent effect.
  - c. Can a fluid exhibit both *memory* effects and *rate-dependent* effects? Discuss.
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. (20 points)
  - a. For *general* and *steady* shear and for general and steady elongation, what is the rate-of-deformation tensor  $\underline{\dot{\gamma}}$ ?
  - b. What is the magnitude of the rate-of-deformation tensor in each case? Show your work for this part.
4. (30 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  $t_{ref} = -\infty$
  - c. Cessation of steady shear, use  $t_{ref} = 0$