MECH 550H – Project – due on October 18th

Pick one of these, according your interests

Project 1: Yield stress fluids

“US Presidents may come and go, but in 100 years from now we will still be using the Bingham fluid model.” I. Frigaard 26th Sept. 2017

Write a critical engineering review, either agreeing or not with the above statement. Maximum 10 pages (in 12pt font) including references.

Notes: Some of the issues that have been raised with yield stress fluids were summarised on the slide titled “The yield stress debate” in lecture 4. You may find Balmforth et al. Ann. Rev Fluid Mech. 46, 121-146 (2014) a useful place to start, but the opinions you express should be your own.

Project 2: Viscoelastic fluids

a) Explain physically what are the differences between the upper convected, lower convected and Jaumann derivatives (2 pages maximum)

b) Find the solution of a steady Poiseuille flow along a plane channel of width 2d, driven by a fixed constant pressure gradient (pressure drop) in the streamwise x direction: \( P_x = -G \), for the following fluids:
   i. Oldroyd-B
   ii. Johnson-Segalman
   iii. Gieskus

For each of b, specify your assumptions on the form of velocity and stress field, then write out those terms in the momentum and stress equations that are non-zero. Simplify the equations using symmetry etc. Solve the equations analytically if possible. In terms of solution, find the velocity, non-zero stress components and give an expression for the 1st and 2nd normal stress differences. Plot these components of the stress for at least one set of parameters. Discuss any restrictions on constant model parameter values that you make in order to find the solutions.

If in need of further exercise you can try:

   c) Couette flow between two concentric cylinders (inner and outer radii \( R_i \) and \( R_o \)), assuming that the outer cylinder is stationary and the shear stress at \( r = R_i \) is fixed: \( \tau_{\theta r} = \tau_i \). Solve this problem for the same 3 fluids as in part b.