

Fluid Mechanics Test 2: Due on 2 Nov 2018 before 17:15.

*All questions are compulsory. Open book, open notes. You may check the internet. But consulting anybody at all even slightly, or even mentioning anything about the exam questions to anybody before turning in the answer sheets is forbidden. Please remember the discussion on ethics we had. (For a scientist, following ethical practices is the most important thing .....)* Answer sheets may be submitted to the Academic Section.

- Q1. A TT player applies a top spin while returning the ball straight across the table (perpendicular to the net). If the maximum speed at which the player can move the bat forward is  $V$ , what is the maximum lift that can be achieved? You may appropriately name other physical quantities as needed, and also, if you wish, pretend the ball is a cylinder. Solve for (to the extent you can), and sketch, the trajectory of the ball before and after impact on the table, neglecting air drag. Use any reasonable model for impact. (7 marks)
- Q2. Show (rigorously) that for homogeneous, isotropic incompressible turbulence, the scaling law for the second-order structure function (discussed in class) is exactly equivalent to the scaling form of the kinetic energy spectrum. (7 marks)
- Q3. A spring on the top of a mountain, where the height  $h = H$ , gives out water at a steady rate of  $Qm^3/s$ . Three rivers of the same constant width and depth are fed by this source and transport water the same lake at the bottom, where  $h = 0$ . They have very different paths  $[x_i(h), y_i(h)]$ , where  $x$  and  $y$  are the horizontal coordinates and  $i = 1, 2, 3$  stands for a given river. What is the flow rate in each at various locations? Make reasonable assumptions where needed. (6 marks)