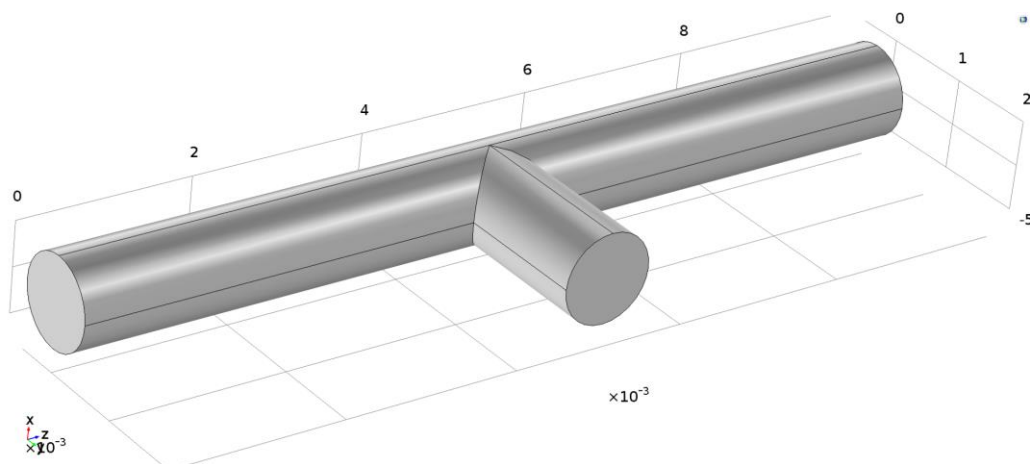


NATIONAL UNIVERSITY OF SINGAPORE  
 ESP5402—TRANSPORT PHENOMENA IN ENERGY SYSTEMS  
 (12:00-17:00; 13 APRIL 2020)  
 OPEN QUIZ

**Answer the following two questions as detailed as possible. You can use any resources available to you, but you must do it alone with no help from someone else. Submit latest 17:00 to LumiNUS. Make sure that your submitted solutions\* both look good and read well.**

**Context:** You are working in a company that develops microfluidic solutions. Right now, you are working on cooling of computer chips. Your project manager is a strong blue with a solid background in linear algebra but not tensor calculus. The company uses SIMSCALE, a cloud-based solution<sup>\*\*,\*\*\*</sup>. Besides giving the answers to the questions below, also document your time management; i.e. how much time you spent on each task.

1. During a meeting, your project manager asks you what " $\nabla \cdot \nabla \mathbf{v}$ " means and where it is relevant. **(5 marks)**
2. Somewhat later that day, your project manager proposes a T-junction for excellent mixing of two water flows as shown in Fig. 1. The water entering from the left is at 50 °C with a speed of 0.1 m/s; and the water entering the shorter pipe is at 10 °C with a speed of 0.05 m/s. Your manager asks you to verify the proposal. **(15 marks)**



**Fig 1.** Schematic of a T-junction. The diameter of the pipes is 1 mm. A CAD entitled "geometry.stl" can be found on LumiNUS.

- \* Points will be deducted for "sloppy" solutions that are poorly narrated or poorly typeset.
- \*\* Register at <https://www.simscale.com/academic-program/> as a student, learn and run your tasks. Give me your username and the name of your project on SIMSCALE so that I can assess it directly if needed.
- \*\*\*If you can't use SIMSCALE, write why and pick another software or paper-and-pen **(up to -10 marks)**.