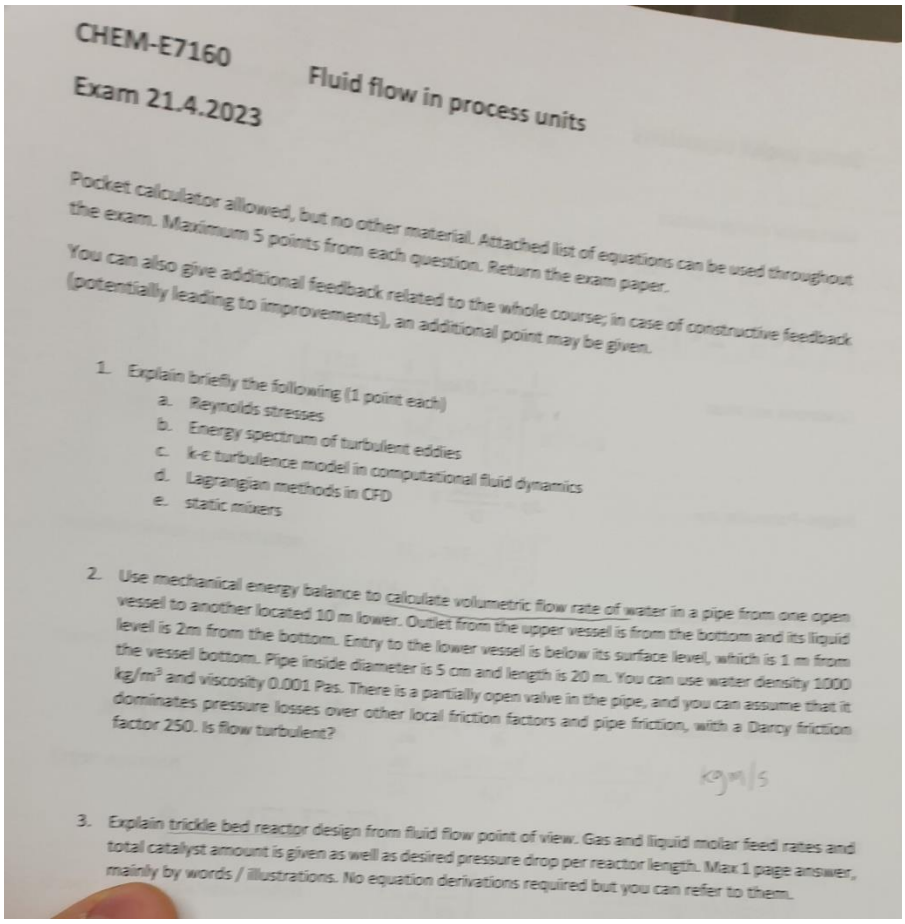
CHEM-E7160 21.4.2023 - Fluid flow in process units.

5 pts each question.

1. Explain briefly the following (1 point each)
   a. Reynolds stresses
   b. Energy spectrum in turbulent eddies
   c. k-e turbulence model in computational fluid dynamics
   d. Lagrangian methods in CFD
   e. static mixers
2. Use mechanical energy balance to calculate volumetric flow rate of water in a pipe from one open vessel to another located 10m lower. Outlet from the upper vessel is from the bottom and its liquid level is 2m from the bottom. Entry to the lower vessel is below its surface level, which is 1 m from the vessel bottom. Pipe inside diameter is 5 cm and length is 20 m. You can use water density 1000 kg/m3 and viscosity 0.001 Pas . There is partially open valve in the pipe, and you can assume that it dominates pressure losses over other local friction factors and pipe friction, with a Darcy friction factor 250. Is flow turbulent?
3. Explain trickle bed reactor design from fluid flow point of view. Gas and liquid molar feed rates and total catalyst amount is given as well as desired pressure drop per reactor length. Max 1 page answer, mainly by words/illustrations. No equation derivations required but you can refer to them.



CHEM-E7160 Fluid flow in process units

Exam 21.4.2023

Pocket calculator allowed, but no other material. Attached list of equations can be used throughout the exam. Maximum 5 points from each question. Return the exam paper.

You can also give additional feedback related to the whole course; in case of constructive feedback (potentially leading to improvements), an additional point may be given.

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   d. Lagrangian methods in CFD
   e. static mixers

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