GEORGIA INSTITUTE OF TECHNOLOGY

COLLEGE OF ENGINEERING

BMED3300 - BIOTRANSPORT

QUIZ 1 (SPRING 2014) – KEMP

STUDENT NAME: Solution

GTID NUMBER: ______________________

RECITATION SECTION: ______________________

(Section A is Wednesdays at 12 noon; Section B is Wednesdays at 10 am)

Closed book
All non-communicating calculator types allowed
Time allotted: 15 minutes
Do all work in this booklet

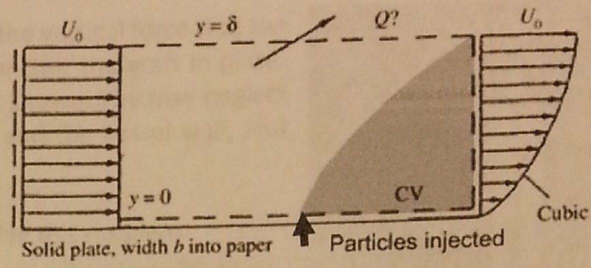
Reminder: for questions requiring numerical answers, units are <u>required</u> and worth 50%

Question	Maximum Mark	Actual Mark
1	6	
2	6	
Total	**12**	

Maximum possible marks are 12. However, the quiz will be marked out of 10, i.e. if you get 8/12, that is equivalent to 80%.

Reynolds transport theorem: $\frac{dB_{system}}{dt} = \frac{\partial}{\partial t}\int_{cv} \rho\beta \; dVol + \int_{cs} \rho\beta \, \mathbf{v} \bullet \hat{\mathbf{n}} \, dS$

1. Fluid flows past a flat plate, with inlet and exit velocity profiles as shown. The density of fluid entering the CV at the left edge is ρ_0. Particles are injected into the fluid through a small hole in the plate at a known rate $\dot{m}_{particle}$ (thick arrow). The particles mix with the fluid (grey region) so that the fluid that leaves through the right edge of the CV has density ρ_1. We wish to know Q at the top of the CV. Note that fluid leaving through the top of the CV has density ρ_0.



a. Is this problem steady or unsteady? State why this is the case.
b. State the physical principle you would use to solve this problem.
c. How would you account for the different values of ρ in this problem?

Note that you do not need to solve the problem; you only need to answer the questions above, which are part of your GIM analysis.

Do your GIM analysis here ①

(a) Steady ①. v's and ρ's do not change with time.
(Note they change with position, but this does not make the problem unsteady.)

②
(b) Conserve mass of fluid + particles. Note conserving mass of fluid alone does not allow a solution to be found.

- Not stating what to conserve mass of is worth 0.
- Just say fluid mass cons ½.

(c) There are 2 inlets & 2 outlets. Since ρ varies between inlets & outlets, we cannot use $\Sigma Q_{in} = \Sigma Q_{out}$. Instead we need to use

① $\Sigma \dot{m}_{in} = \Sigma \dot{m}_{out}$, which requires using correct ρ at various inlet/outlets.

①.

6

2. Consider a stent graft as shown. We wish to compute the vertical force that the hooks on the graft must exert on the vessel wall to anchor the graft in place. Assume that all needed physical parameter values are known. You may neglect the effects of gravity and friction between the graft and the vessel wall, and assume steady conditions.

   a. State the physical principle(s) you would use to solve this problem.
   b. Draw a suitable control volume on the picture above and add any labels to the diagram that will be useful. Explain why the control volume is suitable. For full marks, the location of your control surface must be unambiguous; use labels to clarify if you need to.
   c. There is a concern that neglecting the effects of gravity might lead to a larger-than-expected error. How would you include the effects of gravity in your analysis? For full marks you need to state what physical parameters you would need to know to include gravity effects.

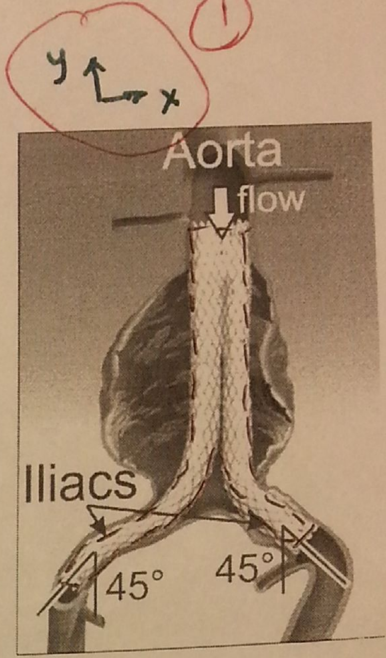


Figure modified from www.aorticstents.com

Note that you do not need to solve the problem; you only need to answer the questions above.

Do your GIM analysis here (parts a and b) 1

(a) Balance ~~x~~ y-momentum under steady conditions (see axes)

(b) See diagram. CV lies between stent graft & artery wall, 1 cuts graft @ inlet & outlet. This CV is good because the CS cuts through the hooks – this means that the force we want to know will appear in the momentum balance. 1

(c) There would be an additional force (weight) 1 in the y momentum balance. We would need to know

1
- mass of graft
- mass of blood in graft
- orientation of y axis w.r.t. g vector

/6

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