COE-C2003 Basic Course on Fluid Mechanics, S2021

Exam Fri 29.10.2021, 08:00 – 12:00 o'clock.

Explain the various stages in the questions. Only equations and final solutions are not enough for full points.

RETURN EACH QUESTION (1 – 5) INTO ITS OWN RETURN BOX IN MyCourses BY 12:00 O'CLOCK !

1. **Answer briefly a total of 6 questions** from the below list of 12 questions. Select questions based on your student number. **Start from the question indicated by the last digit of your student number**. If it is e.g. 6, then start from the question 6 and proceed until question 11, i.e. a total of 6 questions. If the last digit is e.g. 2, start from the question 2 and proceed until question 7. If the last digit is zero, start from the question 10 and proceed until question 3.
   Each question gives max 1p. Answer at most with a couple of sentences per question.

   1 How is shear stress connected to flow field for a Newtonian fluid ?
   2 For a rectangular shaped object affected by the hydrostatic force, can the hydrostatic force be reduced to the centroid of the rectangle, if the rectangle is vertically orientated ? Justify your answer.
   3 What does Eulerian and Lagrangian descriptions mean ?
   4 What is the difference between a control volume and a system ?
   5 What does local acceleration mean ? And what does convective acceleration mean ?
   6 In general, what restrictions are there for applying the standard Bernoulli equation ?
   7 What does the Reynolds Transport theorem mean ?
   8 What means streakline ? And what does streamline mean ?
   9 How would you justify the use of dimensional analysis for model tests ?
   10 How is the shape of an object and the Reynolds number affecting the behavior of the boundary layer ?
   11 What does the Moody-diagram describe ?
   12 How would you define a pump and a turbine ?

2. There is an angle of 90° in a pipe elbow in the vertical plane (see Fig. 1). The flow cross section of the pipe is constant at D = 400 mm. The elbow flow passage volume is 0.2 m^3 between sections (1) and (2). The water volume flowrate is 0.5 m^3/s and the elbow inlet and outlet pressures are 100 kPa and 80 kPa. The elbow mass is 10 kg. Calculate the horizontal (x-direction) and vertical (z-direction) anchoring forces required to hold the elbow in place.

   A Draw the control volume that you can use to define the forces. Define the control volume accurately; how is it oriented compared to the elbow. (1p)

   B Mark and name all the forces to the control volume you have drawn. (1p)

   C Define the anchoring force components (x- and z – components) (4p)

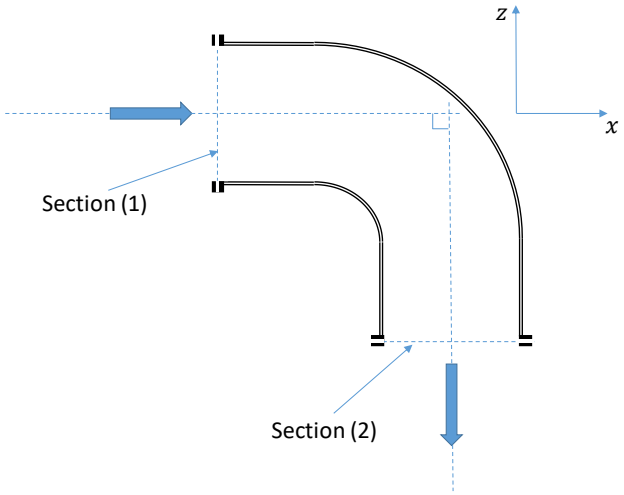

Figure 1. Question 2.

3. Water is flowing in the pipe according to the Fig. 2. What is the volume flow rate Q when the effect of viscosity is not taken into account. Glycerol has SG = 1.26. (6p)

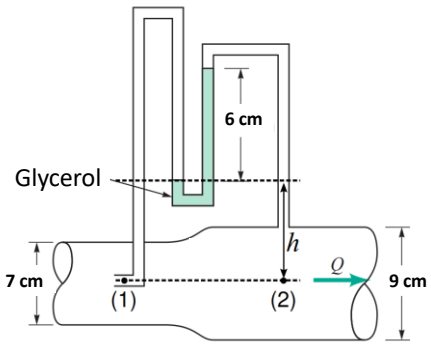

Figure 2. Question 3.

4. The inner radius of a turbine blade row is r_2 = 0.3 m, and the outer radius is r_1= 0.6 m. The turbine wheel rotates at the rate of 100 rpm in the direction shown in the Fig. 3. The absolute velocity vector at the turbine rotor entrance makes an angle of 10° with the tangential direction. The inlet blade angle is 50° relative to the tangential direction. The blade outlet angle is 140°. The flowrate is 1.0 m^3/s and the fluid is water. For the flow tangent to the rotor blade surface at inlet and outlet, determine an appropriate constant blade height, *b*, and the corresponding power available at the rotor shaft. (6p)

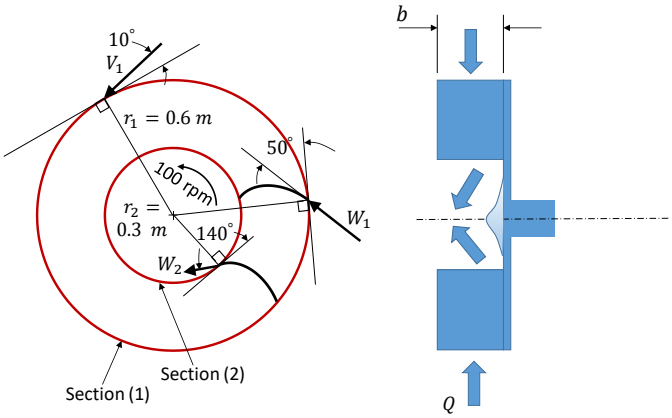

Figure 3. Question 4.

5. A golf ball has dimples on its surface, Fig. 4. Explain why they are used, what is their effect, and what is the physics behind this. (6p)

Figure 4. The surface of a golf ball.