COE-C2003 Basic Course on Fluid Mechanics, S2022

Exam Fri 9.12.2022, 13:00 – 17:00 o'clock, room 326

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

RETURN EACH QUESTION (1 – 5) INTO A SEPARATE PAPER !

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

2. A nozzle is attached to a vertical pipe according to the Figure 1. The gage pressure at the flange is 80 kPa when the flow rate is 0.30 m^3/s. Determine the vertical supporting of the anchoring force required to hold the nozzle in place. The nozzle has a weight of 300 N and volume of the water in the nozzle is 0,01 m^3. The fluid is water ($\rho = 1000\ kg/m^3$). Is the anchoring force directed upward or downward ? (6p)

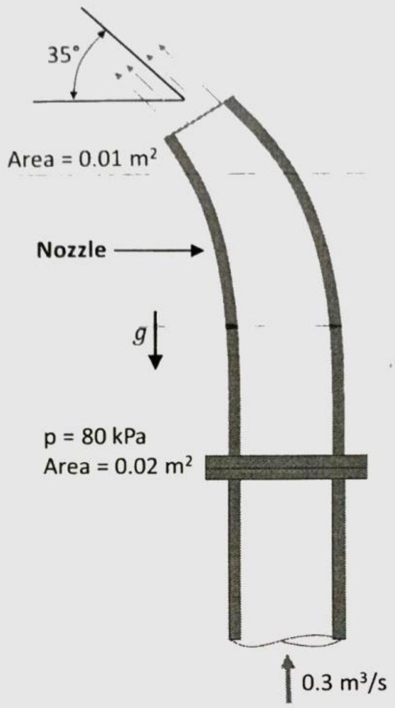

Figure 1. Question 2.

3. A large, open tank has water ($\rho = 1000\ kg/m^3$). The tank is connected to a 1.1 m high, rectangular shaped, pipe (Fig. 2). The rectangular shaped plug is used to seal the pipe. Determine the magnitude, direction, and location of the force of the water on the plug. Hint: the 2nd moment of the area for the plug is calculated from $I_{XC} = \frac{1}{12}ba^3$. (6p)

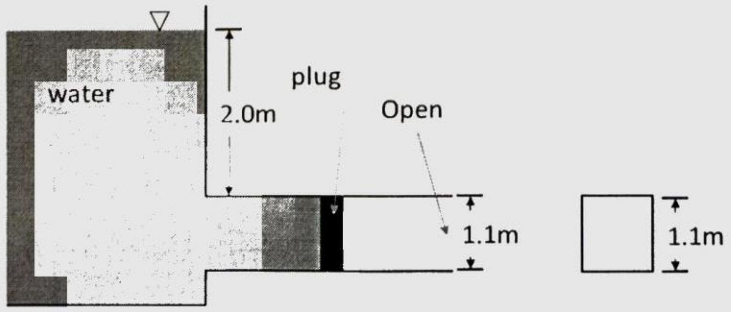

Figure 2. Question 3.

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 ($\rho = 1000\ kg/m^3$). 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)

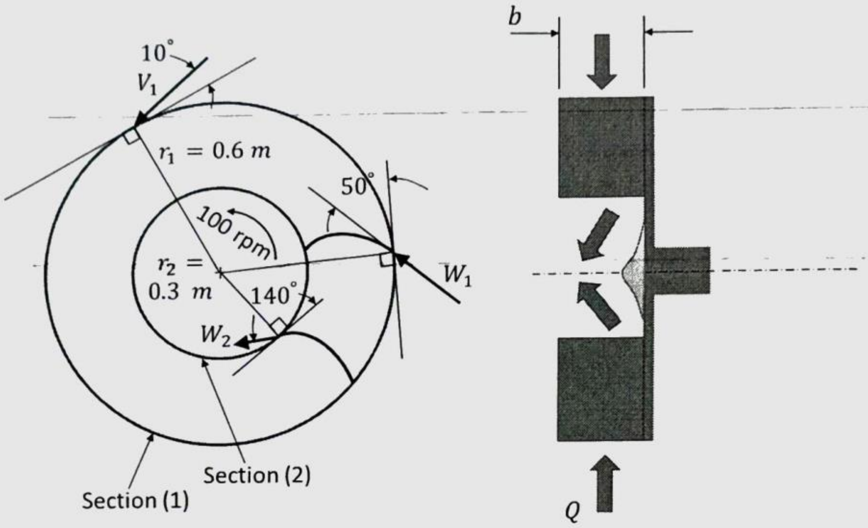

Figure 3. Question 4.

5. A fluid flows through the horizontal curved pipe of Fig. 4 with a velocity V. The pressure drop, Δp, between the entrance and the exit to the bend is thought to be a function of the velocity, bend radius, R, pipe diameter, D, and the fluid density, ρ. The data shown below table were obtained in the laboratory. For these tests $\rho = 1030$ kg/m³, $R = 0.15$ m, and $D = 0.03$ m. Perform a dimensional analysis and, based on the data given, determine if the variables used for this problem appear to be correct. Explain how you arrive at your answer. (6p)

V (m/s)	1.0	3.0	5.0	6.0
$\Delta p\ (kPa)$	9	34	52	61

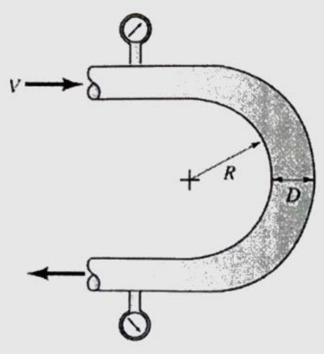

Figure 4. Question 5.