Birla Institute of Technology and Science Pilani, K K Birla Goa Campus

FIRST SEMESTER 2022-2023

ME F212 Fluid Mechanics

Mid Semester Test (Closed Book)

DATE: 02/11/2022 **Time: 2:00 P.M - 3:30 P.M.** **Maximum Marks: 70**

Instructions:

- Please show your work steps. State your assumptions and justify your equations. Partial credit will be awarded on careful and clear arguments. Wrong unsupported numerical answers can only receive zero credit.
- Support your answers with appropriate sketches or free-body diagrams.
- **Predefine all the symbols used.**

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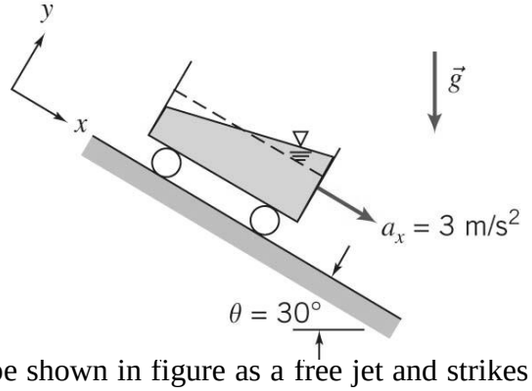
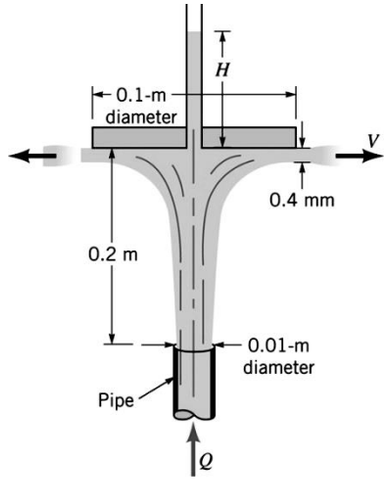
1. The stem of a glass hydrometer used to measure specific gravity is 5 mm in diameter. The distance between marks on the stem is 2 mm per 0.1 increment of specific gravity. Calculate the magnitude and direction of the error introduced by surface tension if the hydrometer floats in kerosene. Assume the contact angle between kerosene and glass is 0^o and the kerosene is having a surface tension of 26.8×10^{-3} N/m and a density of 1430 kg/m^3. **[10]**

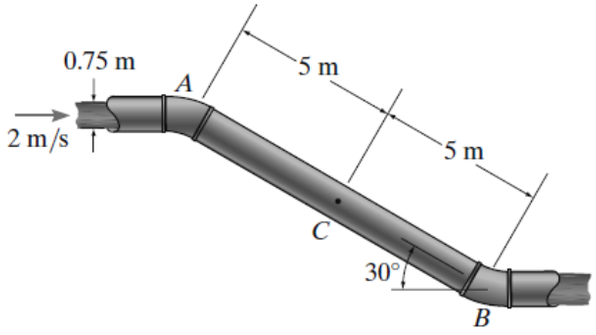
2. A rectangular container of water undergoes constant acceleration down an incline as shown. Derive the expression for slope (dy/dx) of the free surface using the coordinate system shown and the equation of motion $(-\nabla p + \rho\vec{g} = \rho\vec{a})$. Obtain the expression for the slope (dy/dx) of the free surface and also calculate it. **[10]**



3. Water flows from the pipe shown in figure as a free jet and strikes a stationary circular flat plate. The flow geometry shown is axisymmetrical. Determine the flowrate and the manometer reading, H. **[10]**



4. Oil flows through the constant-diameter pipe such that at *A* the pressure is 50 kPa, and the velocity is 2 m/s. Draw the energy and hydraulic grade lines (show the value of elevation for each lines) for *AB* using a datum at *B*. Also plot the pressure head, velocity head and elevation head (show the value of elevation for each heads) from *A* to *B* with reference to the datum set through *B*. Take ρ_{oil} = 900 kg/m^3. **[10]**



5. An air-hockey puck has a mass of 50 g and is 9 cm in diameter. When placed on the air table, a 20ºC air film, of 0.12-mm thickness, forms under the puck. The puck is struck with an initial velocity of 10 m/s. Assuming a linear velocity distribution in the air film, how long will it take the puck to (a) slow down to 1 m/s and (b) stop completely? Also, (c) how far along this extremely long table will the puck have traveled for condition (a)? Take the absolute viscosity of the air as 1.8×10^{-5} kg/m.s. **[14]**

6. A sluice gate is in the form of a circular arc of radius '*R*' as shown in figure. The gate width is '*W*'. **Using the integration method**, obtain the expressions for (a) the magnitude and line of action (with respect to point 'O' shown in figure) of the horizontal force on the gate due to the fluid, (b) the magnitude and line of action (with respect to point 'O' shown in figure) of the vertical force on the gate due to the fluid. **[16]**