Department of Mechanical and Aerospace Engineering
CARLETON UNIVERSITY
MAAE 2300 Fluid Mechanics I

SAMPLE MIDTERM EXAMINATIONS - ANSWERS

Note that depending on the date that the Midterm Examination is written, the material covered can vary from year to year.

Fall 2013

1. $Q = 64.9\ m^3/s$

2. (a) $P_1 = 99235$ Pa(a)
   (b) $Q = 0.461$ litres/min

3. $F = 6598$ N (tension)

Fall 2012

1. 3.53 kPa(g)

2. (a) (i) 784.8 Pa(g) (ii) 101085 Pa(a)
   (b) $Q = 30.0\ m^3/min$
   (c) 0.572 kg/s

3 (a) 127680 Pa(a)
   (b) CV should completely enclose the nozzle and cut through the flanged joint at F to make the forces in the flanged joint appear as forces on the CV.
   (c) Flange forces
   x-direction $F_{Fx} = 9000$ N (tension)
   y-direction $F_{Fy} = 4000$ N

Fall 2011

1. F 13 lb_f

2. H = 40.9 m

3. (a) $V_1 = V_2 = 10.18$ m/s
   (c) Fx = -670.8 N
   Fy = 2563 N
   (d) Tension

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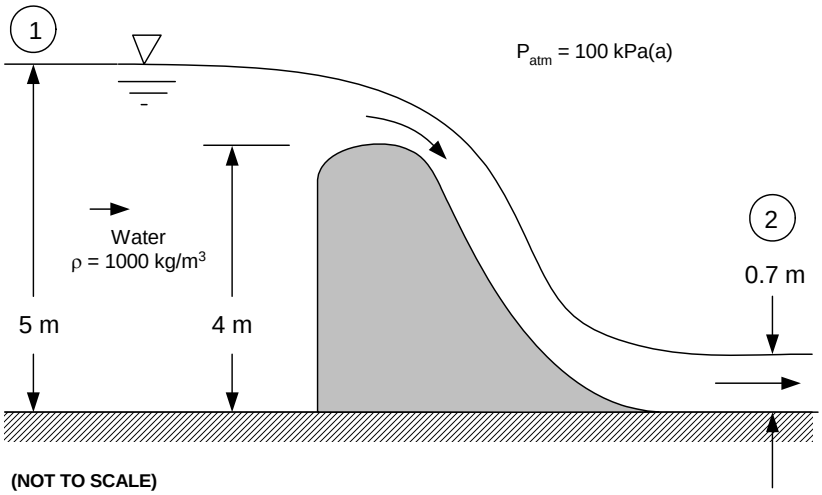
ENGINEERING MAAE 2300A - FLUID MECHANICS I
Midterm Examination - November 2013 (1 hr 20 min.)

ATTEMPT ALL 3 QUESTIONS. THE VALUE OF EACH QUESTION IS GIVEN IN THE MARGIN. PLEASE USE <u>BOTH</u> SIDES OF THE PAGE IN THE ANSWER BOOKLET.

$g = 9.81$ m/s^2 $\quad \rho_{water} = 1{,}000$ kg/m^3 $\quad$ S.G. = Specific Gravity = ρ / ρ_{water}
$R_{air} = 287$ J/kgK

1. The drawing shows the spillway in a river. The spillway is located in a channel that is 10 m wide in the horizontal direction (into the page). Friction may be neglected. For the depths of water shown before and after the spillway determine the flow rate of water, in m^3/s, that is flowing in the channel.

[15]



2 The drawing on the next page shows a simple insecticide sprayer that is intended to be attached to a garden hose. The insecticide (S.G. = 1.2) is drawn from the reservoir to mix with the water and the mixture is then sprayed through the 2.5 mm diameter outlet nozzle. Neglect friction in your analysis. State any other simplifying assumptions used. As indicated in the drawing, the insecticide has been drawn up the 1.0 mm diameter tube but is not flowing into the sprayer tube. The reservoir with the insecticide has an opening to the atmosphere, as shown.

[8] (a) Determine the pressure in Pa(a) at location 1 on the centreline of the sprayer tube.

[12] (b) Assuming that you obtained a pressure of 99,235 Pa(a) at location 1 (Note that this is not necessarily the pressure you should have obtained in Part (a)) what is the flow rate of water in litres/min (recall that 1 m^3 = 1000 litres) for the conditions shown in the drawing?

[20]

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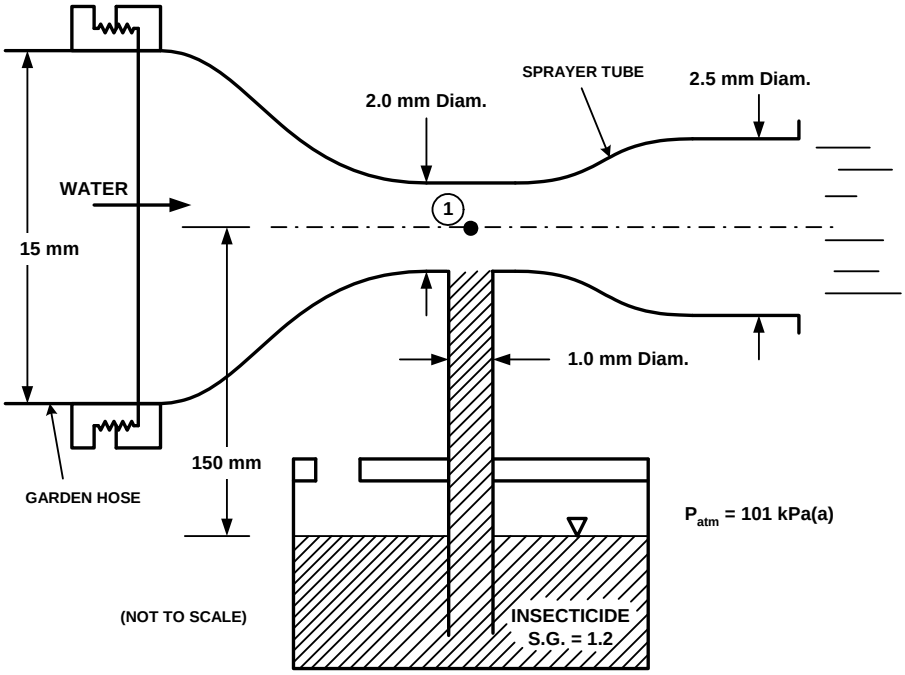


3. Water flows through the reducing pipe bend shown in the drawing. The known conditions are as follows:

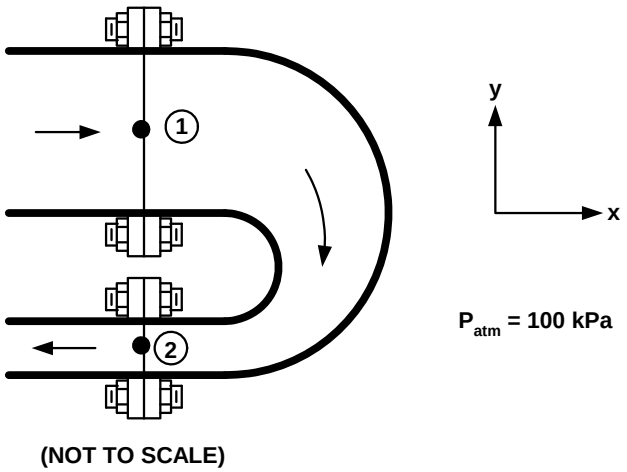
$V_1 = 2$ m/s $\qquad P_2 = 150$ kPa(a)

and the pipe diameters at the flanged joints are

$D_1 = 30$ cm $\qquad D_2 = 20$ cm

Calculate the <u>total</u> force in the x direction that must be resisted by the bolts in the two flanged joints. Assume that the joint lies in a horizontal plane. Neglect the weight of the pipe bend and the water inside it. State any other simplifying assumptions made.

[25]



[50]

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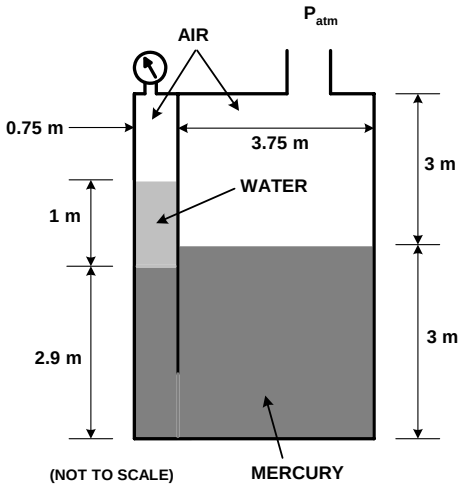
ENGINEERING MAAE 2300 - FLUID MECHANICS I
Midterm Examination - October 2012 (1 hr 20 min.)

ATTEMPT ALL 3 QUESTIONS. THE VALUE OF EACH QUESTION IS GIVEN IN THE MARGIN. PLEASE USE <u>BOTH</u> SIDES OF THE PAGE IN THE ANSWER BOOKLET.

$g = 9.81$ m/s^2 $\quad \rho_{water} = 1{,}000$ kg/m^3 $\quad \rho_{mercury} = 13{,}600$ kg/m^3
$R_{air} = 287$ J/kgK

1. The drawing shows a partitioned tank containing water and mercury. The right chamber is open to the atmosphere. What is the gauge pressure of the air trapped in the left chamber?

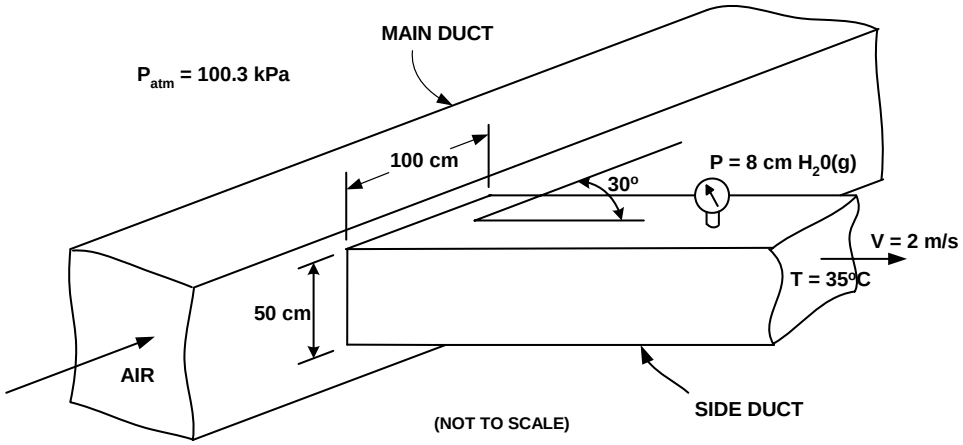


[12]

2. The drawing shows a section of the ducting for a forced-air heating system. The side duct branches from the main duct at an angle of 30°, as shown. The flow in the side duct can be taken as one-dimensional and the velocity has been measured at 2 m/s. A temperature gauge indicates that the air in the side duct is at a temperature of 35°C and a pressure gauge shows a pressure of 8 cm H_2O(g).

[4] (a) What is the pressure of the air in the side duct: (i) in Pa(g)? (ii) in Pa(a)?
[5] (b) What is the volume flow rate of air in the side duct in m^3/min?
[5] (c) What is the mass flow rate of air in the side duct in kg/s?

[14]



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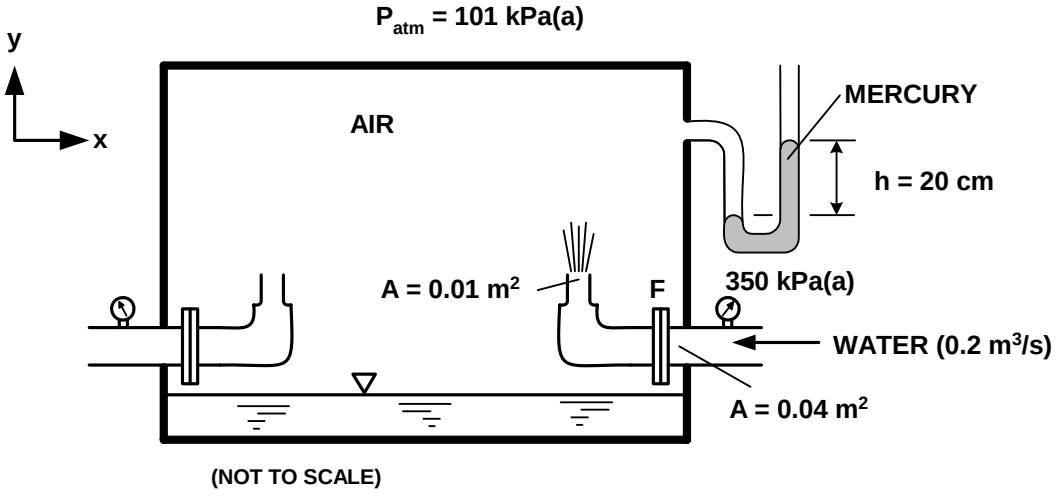
3. The drawing shows a mixer tank used in a chemical plant. Liquids can be sprayed into the contents of the tank using the two nozzles. Assume that water is being sprayed into the tank at a rate of 0.2 m^3/s through the right-hand nozzle. The nozzle contracts from an area of 0.04 m^2 in the pipe to an area of 0.01 m^2 at the nozzle outlet. The tank is closed and the space above the liquid contains pressurized air.

[4] (a) What is the pressure of the air in the tank at the instant shown in the drawing? Quote the result in kPa(a).

[5] (b) Draw and fully label the control volume you would use analyze the forces and moments in the flanged joint F.

[15] (c) Assuming a value of the pressure in the tank of P_{tank} = 150 kPa(a) (**Note**: This is <u>not</u> the value you should have obtained in part (a)), determine the magnitude and direction of the vertical (y direction) force and horizontal (x direction) force in the flanged joint F. Neglect the weight of the piping and the weight of the water inside it. Indicate whether the flanged joint is in tension or compression, explaining briefly the basis for your conclusion. A pressure gauge indicates that the pressure in the water pipe upstream of the flange is 350 kPa(a). This value may be assumed to apply also at the flange.

[24]



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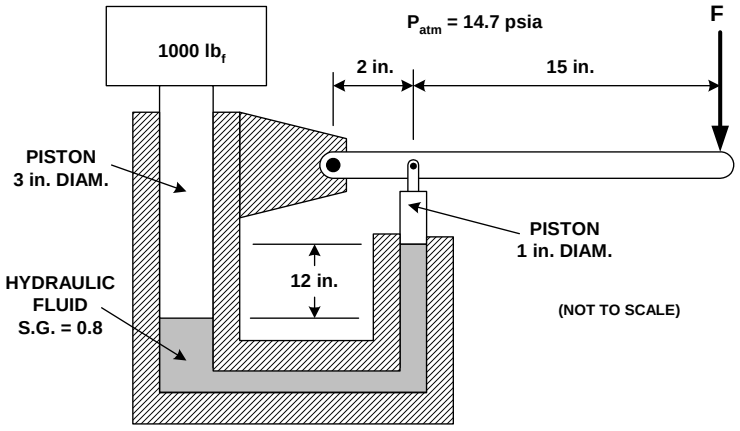
MAAE 2300 Fluid Mechanics I
Midterm Examination - November 2011 - Duration: 1 ½ hours

ATTEMPT ALL 3 QUESTIONS. THE VALUE OF EACH QUESTION IS GIVEN IN THE MARGIN. PLEASE USE <u>BOTH</u> SIDES OF THE PAGE IN THE ANSWER BOOKLET.

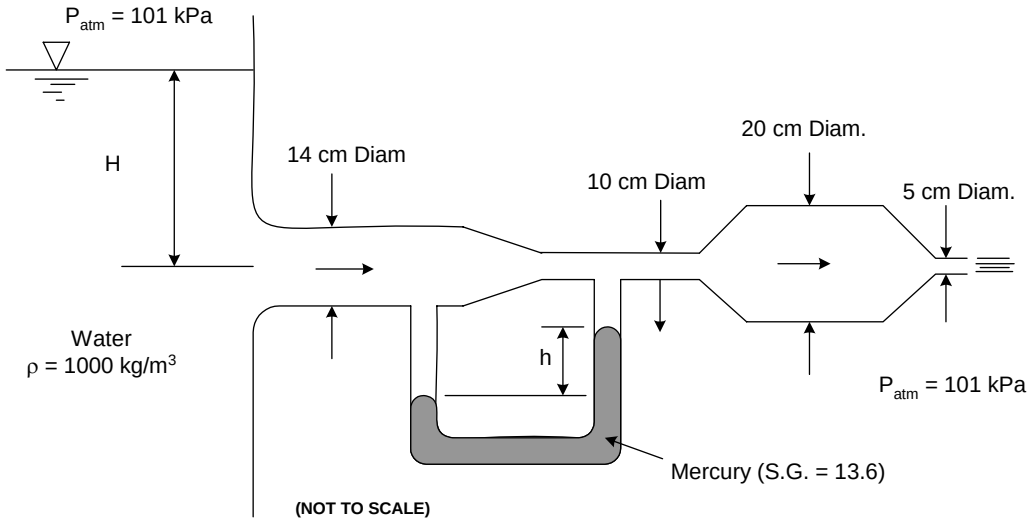
$g = 9.81\ m/s^2 = 32.174\ ft/sec^2$ $\rho_{water} = 1{,}000\ kg/m^3 = 62.4\ lb_m/ft^3$ $R_{air} = 287\ J/kgK$
$1\ slug = 32.174\ lb_m$ $1\ ft. = 12\ in.$

1. The drawing shows a simple hydraulic jack. The hydraulic fluid has a specific gravity (S.G.) of 0.8. Determine the force F that must be applied to the handle to support the 1000 lb_f weight. Neglect the weight of the two pistons.

[15]



2. Water flows through the system shown in the drawing. For your analysis assume one-dimensional flow and neglect friction and all other losses in the system. Determine the height of water, H, in the tank if h = 15 cm for the mercury U-tube manometer.



[20]

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3. The drawing shows a two-outlet nozzle that is used to spray water inside a closed tank containing a pressurized gas. For a volume flow rate of water is 0.1 m^3/s and with a gas pressure inside the tank of 300 kPa(a), the pressure gauge on the inlet pipe indicates a pipe pressure of 250 kPa(g) in the water. The velocity at the outlet of the two nozzles is expected to be the same: $V_1 = V_2$. The pipe supplying the water is horizontal. The drawing is a plan view and thus the weight of the nozzle and the weight of the water inside it will act in the negative z direction for the co-ordinate system shown. The flow may be assumed to be one-dimensional everywhere.

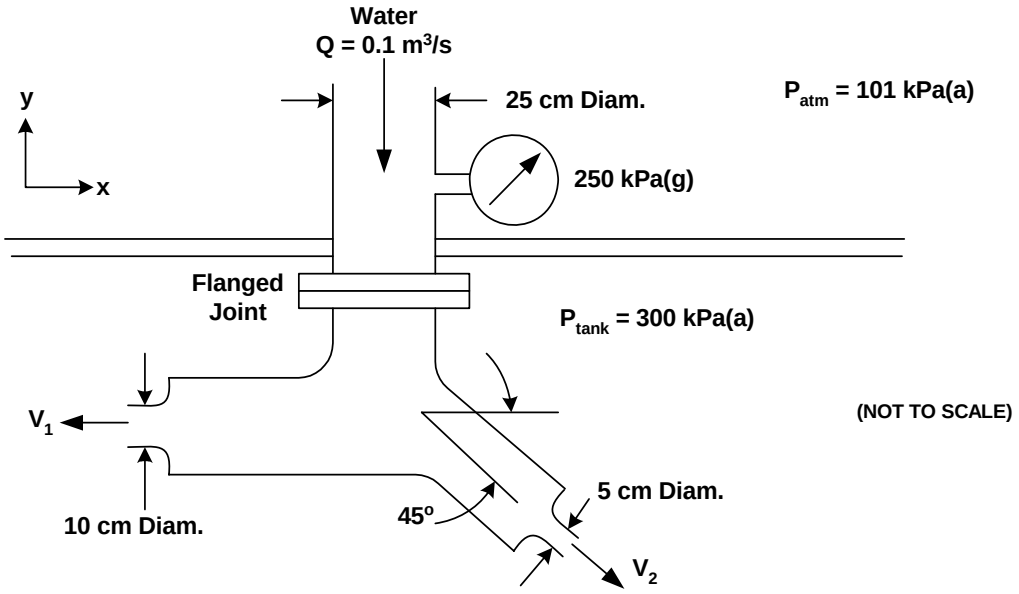
[4] (a) What is the velocity at the outlet of the two nozzles, V_1 and V_2, in m/s?

[6] (b) Draw and fully label a control volume that can be used to solve for the forces in the x and y directions at the flanged joint shown. The diagram should show the values of all flow quantities (pressures, velocities, etc.) needed to solve for the forces.

[12] (c) Determine the forces in the flanged joint in the x and y directions.

[3] (d) Is the flanged joint in tension or compression? Briefly explain your reasoning.

[25]



[60]