

FINAL
Examination Paper

(COVER PAGE)

Session : April 2019

Programme : Diploma In Mechanical Engineering (DMEN)

Course : EGR2178 : Fluid Mechanics 1

Date of Examination : July 31, 2019 (Wednesday)

Time : 5:00 pm – 7:00 pm Reading Time: Nil

Duration : 2 Hours

Special Instructions :

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet

provided. All questions carry equal marks.

Materials permitted : Non-Programmable Calculator

Materials provided : Nil

Examiner (s) : Iylia Elena Abdul Jamil and Nur Hafizah Habideen

Moderator : Dr Idris Saad

This paper consists of 7 printed pages, including the cover page.

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGR2178: FLUID MECHANICS 1
FINAL EXAMINATION: APRIL 2019 SESSION

Instructions : This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provide. All questions carry equal marks.

Question 1

- (a) The 200-kg, 5-m-wide rectangular gate shown in Figure Q1 (a) is hinged at B and leans against the floor at A making an angle of 45° with the horizontal. The gate is to be opened from its lower edge by applying a normal force at its center. Determine the minimum force F required to open the water gate.

(10 marks)

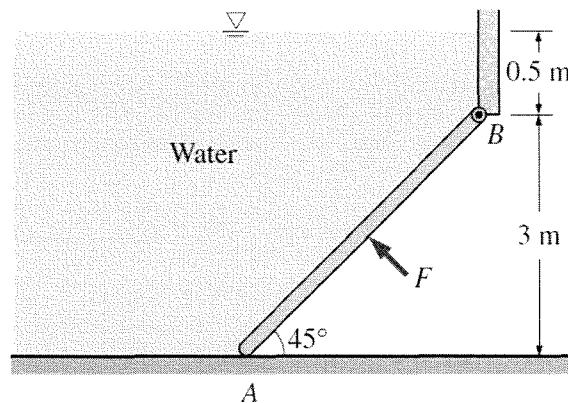


Figure Q1 (a)

- (b) A 170-kg granite rock ($\rho = 2700 \text{ kg/m}^3$) is dropped into a lake. A man dives in and tries to lift the rock. Determine the force that man needs to apply to lift the granite rock from the bottom of the lake.

(6 marks)

- (c) Explain the process of cavitation in fluid mechanics.

(9 marks)

Question 2

- (a) Fluid flows can be classified into many different categories including laminar and turbulent.
- Explain the difference between a laminar flow and a turbulent flow.
 - State the parameters to determine the type of flow (i.e. laminar or turbulent).
- (6 marks)
- (b) The pressure of water flowing through a pipe is measured by the arrangement shown in Figure Q2 (b). Calculate the pressure in the pipe A.
- (8 marks)

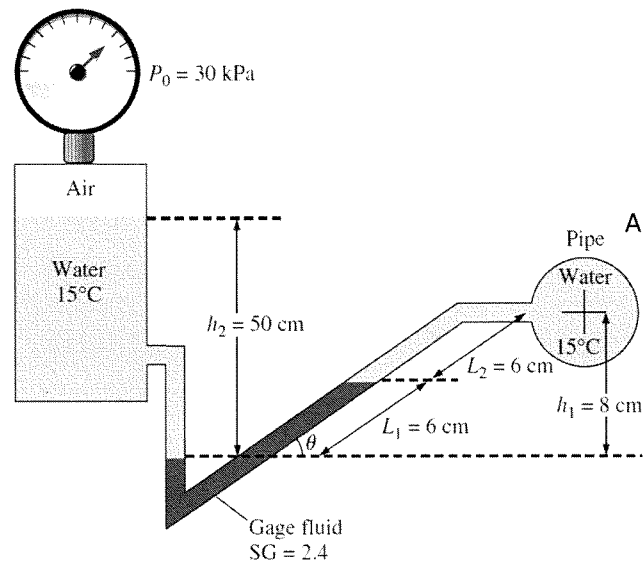


Figure Q2 (b)

- (c) Derive the primary dimensions of the *universal ideal gas constant* R_u based on the ideal gas equation. (5 marks)
- (d) A large water tank as shown in Figure Q2d is open to the atmosphere. A tap near the bottom of the tank is now opened, and water flows out from the smooth and rounded outlet. Determine the water velocity at the outlet. (6 marks)

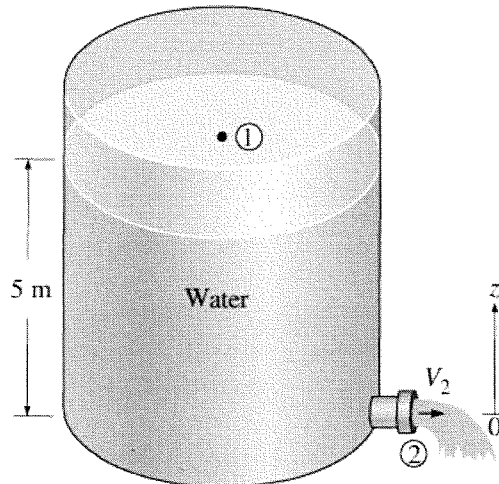


Figure Q2 (d)

Question 3

- (a) A 1-m^3 rigid tank initially contains air whose density is 1.18 kg/m^3 . The tank is connected to a high-pressure supply line through a valve. The valve is opened, and air is allowed to enter the tank until the density in the tank rises to 7.20 kg/m^3 . Determine the mass of air that has entered the tank. (6 marks)
- (b) A horizontal 5-cm-diameter water jet with a velocity of 18 m/s impinges normally upon a vertical plate of mass 1000 kg . The plate is held in a frictionless track and is initially stationary. When the jet strikes the plate, the plate begins to move in the direction of the jet. The water always splatters in the plane of the retreating plate. Determine:
- the acceleration of the plate when the jet first strikes it (time = 0), (6 marks)
 - the time it will take for the plate to reach a velocity of 9 m/s , and (3 marks)
 - the plate velocity 20 s after the jet first strikes the plate. Assume the velocity of the jet relative to the plate remains constant. (3 marks)

- (c) Oil flows in a pipe 80 mm bore diameter with a mean velocity of 0.4 m/s. The density is 890 kg/m^3 and the viscosity is 0.075 Ns/m^2 . Show that the flow is laminar and hence calculate the pressure loss per meter length. (7 marks)

Question 4

- (a) The water jet at 15 m/s strikes the vertical surface of a cart that moves horizontally at a constant velocity of 5 m/s, as shown in Figure Q4a. The mass flow rate of water is 25 kg/s. After the strike, the water stream splatters off in all directions in the plane of the back surface. Determine:
- (i) The force that needs to be applied on the brakes of the cart to prevent it from accelerating. (8 marks)
 - (ii) The maximum amount of power that can be generated if this force were used to generate power instead of wasting it on the brakes. (4 marks)

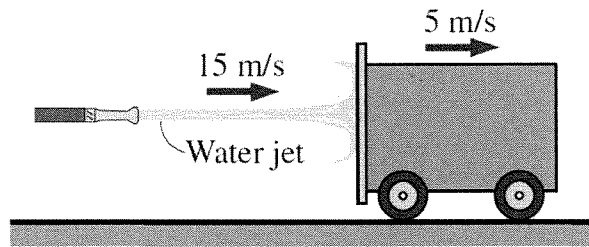


Figure Q4 (a)

- (b) Air flows through a pipe at a rate of 200 L/s, as shown in Figure Q4 (b). The pipe consists of two sections of diameters 20 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 kg/m^3 (13 marks)

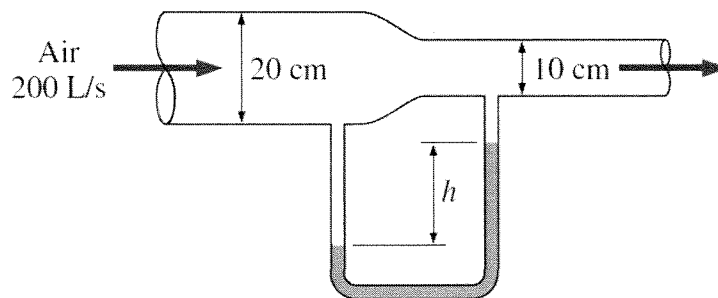


Figure Q4 (b)

Question 5

- (a) A 90° elbow is used to direct water flow at a rate of 25 kg/s in a horizontal pipe upward as shown in Figure Q5 (a). The diameter of the entire elbow is 10 cm. The elbow discharges water into the atmosphere, and thus the pressure at the exit is the local atmospheric pressure. The elevation difference between the centers of the exit and the inlet of the elbow is 35 cm. The weight of the elbow and the water in it is negligible. Assume the pipe is frictionless.

(i) Determine the gage pressure at the center of the inlet of the elbow. (7 marks)

(ii) Determine the anchoring force needed to hold the elbow in place. (8 marks)

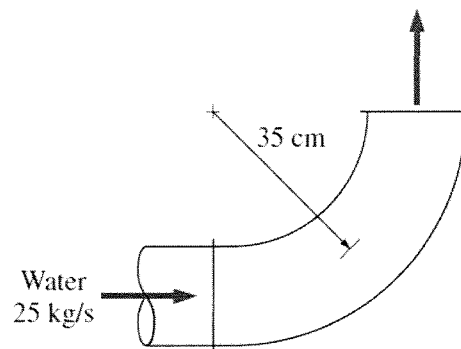


Figure Q5 (a)

- (b) Oil at 20°C ($\rho = 888 \text{ kg/m}^3$ and $\mu = 0.800 \text{ kg/m} \cdot \text{s}$) is flowing steadily through a 5-cm-diameter of a 40-m-long pipe. The pressure at the pipe inlet and outlet are measured to be 745 kPa and 97 kPa, respectively. Determine the flow rate of oil through the pipe for the following cases:

(i) When the pipe is horizontal. (4 marks)

(ii) When the pipe is inclined 15° upward. (2 marks)

(iii) When the pipe is inclined 15° downward. (2 marks)

(iv) Verify that the flow through the pipe is laminar. (2 marks)

Question 6

- (a) Consider fully developed flow between two infinite parallel plates separated by distance h , with the top plate moving and the bottom plate stationary as illustrated in Figure Q6a. The flow is steady, incompressible, and two-dimensional in the xy -plane. Use the method of repeating variables to generate a dimensionless relationship for the x -component of fluid velocity u as a function of fluid viscosity μ , top plate speed V , distance h , fluid density ρ , and distance y . Show all your work.

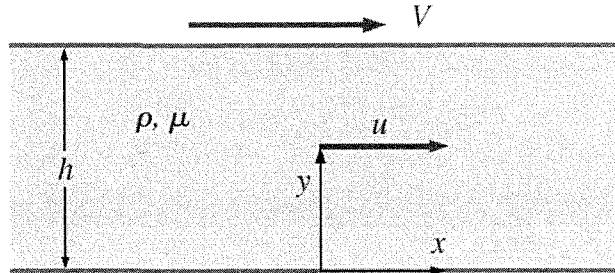


Figure Q6 (a)

(18 marks)

- (b) A laminar flow wind tunnel has a test section that is 40 cm in diameter and 60 cm in length. The air is at 20°C and flowing at a uniform speed of 2.0 m/s at the test section inlet. Take kinematic viscosity of air at 20°C as $1.516 \times 10^{-5} \text{ m}^2/\text{s}$.
- (i) Determine the Reynold's number of the flow at the end of the test section. (2 marks)
- (ii) Calculate the air centerline speed at the end of the test section. (2 marks)
- (iii) Find the percentage increment of air speed between the two ends of the test section.

(3 marks)

-THE END-