**FINAL**
**ALTERNATIVE ASSESSMENT**

(COVER PAGE)

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| Session | : | **April 2020** |
| Programme | : | Diploma in Mechanical Engineering (DMEN) |
| Course | : | **EGR2178: Fluid Mechanics 1** |
| Date of Examination | : | 8 August 2020 (Saturday) |
| Time | : | 8.00am – 10.15am    Reading Time : Nil |
| Duration | : | 2 Hours 15 Minutes |

**Special Instructions :**

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Nil

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| Examiner(s) | : | **Ms Nur Hafizah Habideen, Ms Iylia Elena Abdul Jamil** |
| Chief Moderator | : | Mr Teow Hsien Loong |

*This paper consists of* ***5*** *printed pages, including the cover page*

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGR2178: FLUID MECHANICS 1
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

**Instructions:** This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

**Question 1**

(a) A propeller operates underwater at an operating temperature of 20°C. At maximum speed, the pressure at the tips of the propeller drops to 2 kPa. The vapour pressure is 2.339 kPa.

i. Determine if there is a danger of cavitation for this propeller.

(4 marks)

ii. Explain why cavitation must be avoided in this operation by describing the process.

(5 marks)

(b) Mercury is filled into a U-tube manometer, as shown in Figure Q1b. The top 18-cm-high portion is left unfilled. The right arm of the U-tube has a diameter of 2 cm, and the left arm has a diameter twice that. Oil with a specific gravity of 2.72 is poured into the left arm, forcing some mercury from the left arm into the right one.

i. Explain what will happen when oil is filled into the left arm.

(2 marks)

ii. Determine the equation that can relate the drop in height of mercury in the left arm, *x* and the rise in height of mercury in the right arm, *h* when oil has filled up the left arm of the U-tube manometer.

(4 marks)

iii. Calculate the value of *x*.

(6 marks)

iv. Determine the volume of oil needed to fill up the U-tube manometer.

(4 marks)

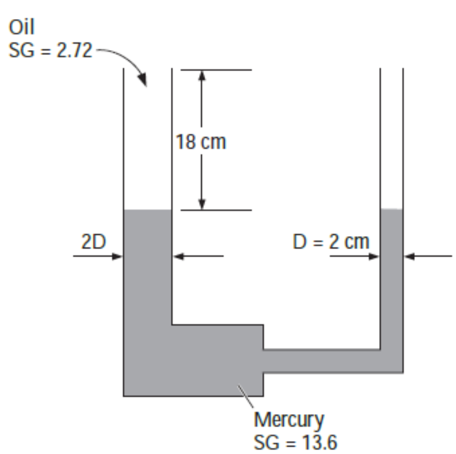


Figure Q1b

**Question 2**

(a) A large cubic ice block is floating in seawater. The specific gravities of ice and seawater are 0.92 and 1.025, respectively. If a 10 cm high portion of the ice block extends above the surface of the water, determine the height of the ice block below the surface.

(8 marks)

(b) The air velocity in the duct of a heating system is to be measured by A Pitot-static probe inserted into the duct parallel to flow. It is used to measured the air velocity in the duct of a heating system. If the difference the water columns connected to the two outlets of the probe is 2.4 cm, determine:

(i) the flow velocity

(ii) the pressure rise at the tip of the probe.

Assume that the air temperature and pressure in the duct are 45 °C and 98 kPa, respectively.

Take $p_w$ = 1000 kg/m$^3$ and R = 0.287 kPa · m$^3$/kg · K.

(8 marks)

(c) A laminar flow wind tunnel has a square test section that is 40 cm in width, 40 cm in height and 60 cm in length. The air is at 20°C. At a uniform air speed of 2.0 m/s at the test section inlet, by how much will the centerline air speed accelerate by the end of the test section? Take $v$ = 1.516 x 10$^{-5}$ m$^2$/s.

(9 marks)

**Question 3**

(a) A tank in Figure Q3a contains air at 102 kPa, while the pressure outside is 100 kPa and 20°C. Take $R = 0.287\ kPa \cdot m^3/kg \cdot K$.

(i) Calculate the density of air in the tank using the ideal gas equation.

(3 marks)

(ii) A tap of diameter 2 cm is open. Determine the maximum flow rate of air through tap.

(6 marks)

(iii) Is the flowrate calculated in **part (i)** realistic? Explain.

(3 marks)

(iv) If the pressure in the tank is 300 kPa, how would it affect the air velocity at the tap?

(3 marks)

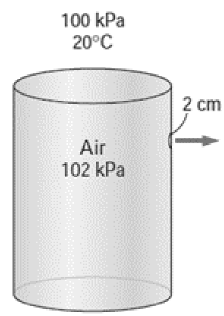


Figure Q3a

(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 initially stationary and held in a nearly frictionless track. 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:

(i) The acceleration of the plate when the jet first strikes it

(6 marks)

(ii) the time it will take for the plate to reach a velocity of 9 m/s

(2 marks)

(iii) the plate velocity 20 s after the jet first strikes the plate

(2 marks)

Assume the velocity of the jet relative to the plate remains constant. Take $\rho_w = 1000\ kg/m^3$.

**Question 4**

(a) In problems involving shallow water waves, both Froude number and Reynolds number are relevant dimensionless parameters. Use dimensional analysis to show this. In Figure Q4a, the wave speed, $c$ of the waves on the surface of a liquid is a function of depth, $h$, gravitational acceleration, $g$, fluid density, $\rho$, and fluid viscosity, $\mu$.

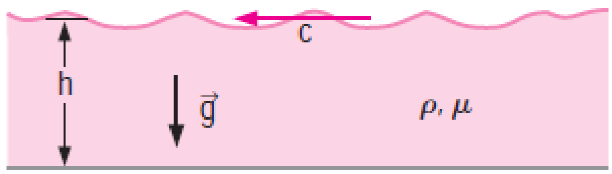


Figure Q4a

(17 marks)

(b) Consider the flow of oil with $p$ = 894 kg/m3 and μ = 2.33 kg/m · s in a 40 cm diameter pipeline at an average velocity of 0.5 m/s. A 300 m long section of the pipeline passes through the icy waters of a lake. Disregarding the entrance effects, determine the pumping power required to overcome the pressure losses and to maintain the flow of oil in the pipe.

(8 marks)

**-THEEND-**