CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
JULY 2025 SEMESTER SESSION

SUBJECT CODE	:	**LMB12102**
SUBJECT TITLE	:	**FLUID MECHANICS**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF MARINE ENGINEERING TECHNOLOGY WITH HONOURS**
TIME / DURATION	:	**9.00 AM – 11.30 AM (2 HOURS 30 MINUTES)**
DATE	:	**23 DECEMBER 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read **CAREFULLY** the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **TWO (2)** Sections; Section A and Section B.
4. Answer **ALL** question in Section A, and **ONLY THREE (3)** questions in Section B.
5. Please write your answers on the answer booklet provided.
6. Answer **ALL** questions in English language only.
7. Table of formulae and appendices has been appended for your reference.

THERE ARE 10 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

With reference to Archimedes' Principle and Bernoulli's Equation

(a) Describe Archimedes' Principle.

(3 marks)

(b) An aluminium rudder stock with a density of 2800 kg/m^3 and a mass of 3600 kg is totally submerged in seawater. A cable is used to pull the rudder out of the water with a winch. Given that the density of seawater is 1020 kg/m^3. Calculate:

i. the volume of the rudder

(3 marks)

ii. the buoyant force that supported the rudder

(3 marks)

iii. the tensional force of the winch when the rudder is in seawater.

(4 marks)

(c) Oil of density 850 kg/m^3 flows in venturi meter as shown in Figure 1. The differential height of mercury between the entrance and the throat is 40 cm and the speed of the oil at the entrance is 10 m/s. If the density of mercury is 13600 kg/m^3, compute:

i. the pressure difference between the entrance and the throat of the pipe

(3 marks)

ii. the speed of the oil flows through the narrow throat.

(4 marks)

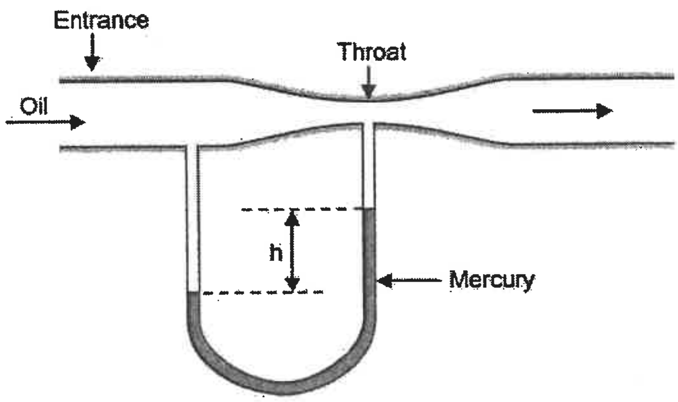

Figure 1

Question 2

With reference to flow rate and Continuity Equation:

Figure 2 shows a supply system with oil flowing into pipe A and discharged through pipes C and D. The speed of oil entering pipe A is 5 m/s and the speed of oil leaving pipe D is 1.5 m/s. The diameters of the pipes are given as in the figure. Calculate:

(a) the volume flow rate at the entrance

(3 marks)

(b) the speed of oil in pipe B

(3 marks)

(c) the diameter in pipe D if it takes 60% of the total flow rate

(5 marks)

(d) the speed of oil discharged from pipe C.

(5 marks)

(e) the mass flow rate of pipe C if the relative density of the oil is 0.78

(4 marks)

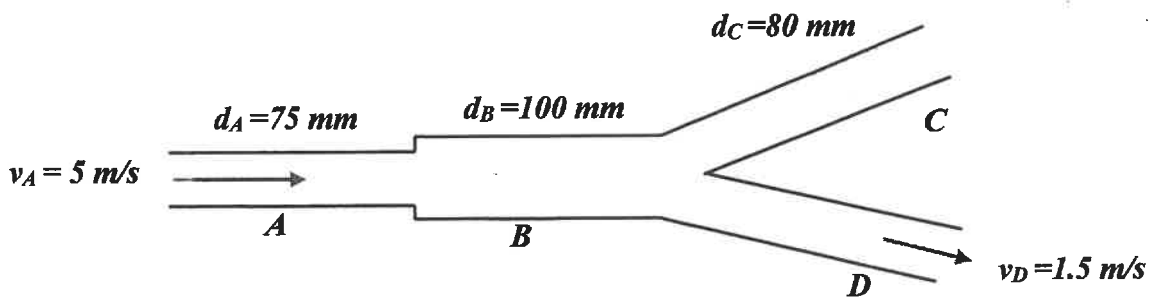

Figure 2

SECTION B (Total: 60 marks)

INSTRUCTION: Answer only THREE (3) questions.
Please use the answer booklet provided.

Question 3

With reference to head loss in the horizontal pipe.

Diesel fuel is pumped at a rate of 180 L/min through a PVC pipe of diameter 150 mm and length 700 m. The relative density of the diesel is 0.83 and the kinematic viscosity of diesel is 3.2×10^{-6} m^2/s. Determine:

(a) the flow regime

(7 marks)

(b) the friction factor

(6 marks)

(c) the pressure drops due to head loss

(7 marks)

Question 4

With reference to head loss due to fittings.

Figure 3 shows water at 20°C is transferred from the lower reservoir to the upper reservoir using a pump at a rate of 15 L/s. The piping system uses a pipe with a diameter of 300 mm and the total length of the pipe is 800 m. In this piping arrangement, the 90° long radius elbow is used. Determine:

(a) the K factors for all fitting

(5 marks)

(b) the head loss in a system if the friction factor of the system is 0.021

(7 marks)

(c) the fluid power if the total head of the system is 6.2 m.

(4 marks)

(d) percentage of efficiency of the pump if the shaft power is 1.5 kW.

(4 marks)

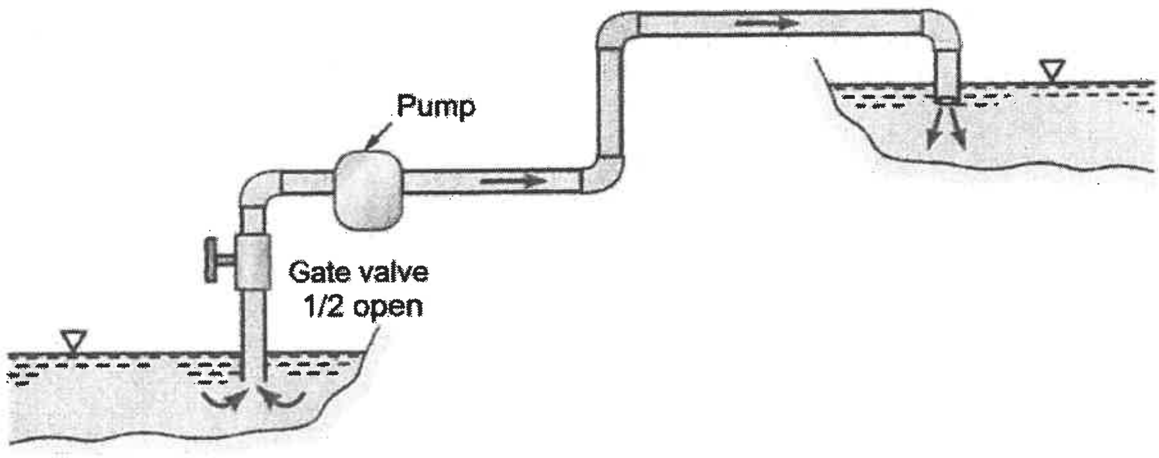

Figure 3

Question 5

With reference to fluid flow in parallel pipes:

Water at 15°C flows through a system as shown in Figure 4. The diameter and the length of each pipe are listed below and the velocity in Pipe 1 is 3 m/s.

Pipe	Diameter (mm)	Length (m)
1	250	180
A	150	80
B	200	100
2	250	300

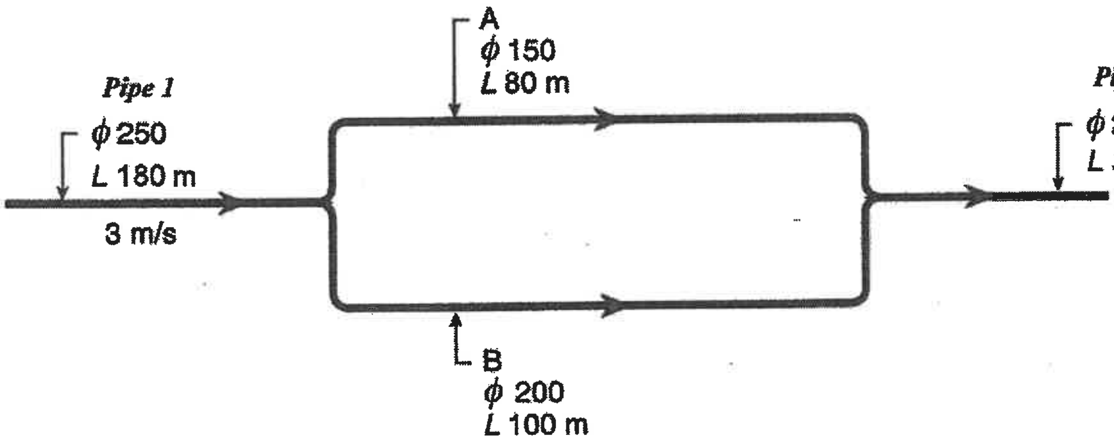

Figure 4

(a) Calculate the friction factor of Pipe 1 if the pipe is made of commercial steel.

(8 marks)

(b) Determine the head loss through the system using an equivalent length of parallel pipes if the friction factor is assumed to be the same for all pipes.

(8 marks)

(c) Calculate the volume flow rate in pipe B if the velocity in Pipe A is 1 m/s.

(4 marks)

Question 6

With reference to fluid force:

A steam jet of 80 mm in diameter is discharged from a nozzle with a velocity of 65 m/s strikes a curved turbine blade and deflected at an angle of 40° as in Figure 5. The specific volume of the steam is 4.2 m^3/kg. Calculate the magnitude and the direction of the force on the blade, if the turbine blade is moving away from the steam jet with a velocity of 10 m/s.

(20 marks)

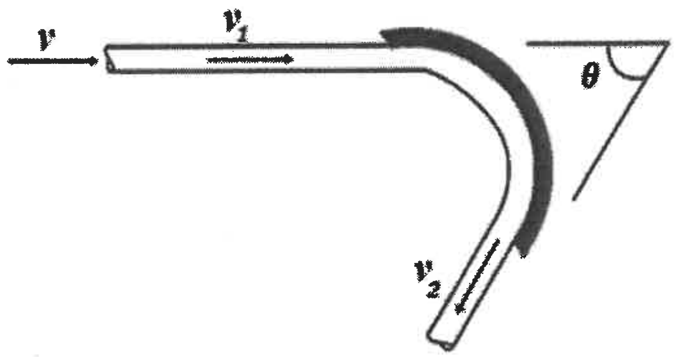

Figure 5

END OF EXAMINATION PAPER

APPENDICES

1. TABLE OF FORMULAE

$\rho = \frac{m}{V}$	$RD = \frac{\rho_{substance}}{1000\ kg/m^3}$
$F_B = W_o$	$F_B = \rho_f V_f g$
$\dot{V} = Av$	$\dot{m} = \rho A v$
$P = \rho g h$	$\Delta P = \frac{1}{2}\rho v_2^2 - \frac{1}{2}\rho v_1^2$
$P + \frac{1}{2}\rho v^2 + \rho g h = constant$	$h + \frac{P}{\rho g} + \frac{v^2}{2g} = constant$
$Re = \frac{vd}{\nu}$	$Re = \frac{\rho v d}{\mu}$
$f = \frac{64}{Re}$	$f = 0.0055\ [1 + (20000\varepsilon_R + \frac{10^6}{Re})^{\frac{1}{3}}]$
$\varepsilon_R = \frac{\varepsilon}{d}$	$\Delta P = \rho g H_L$
$H_L = \frac{fLv^2}{d2g}$	$H_L = \Sigma K \frac{v^2}{2g}$
$H_L = \left(\frac{fL}{d} + \Sigma K\right)\frac{v^2}{2g}$	$P_f = \dot{m} g H$
Series pipes: $\frac{f_E L_E}{d_E^5} = \frac{f_A L_A}{d_A^5} + \frac{f_B L_B}{d_B^5} + \cdots$	*Parallel pipes:* $\left(\frac{d_E^5}{f_E L_E}\right)^{\frac{1}{2}} = \left(\frac{d_A^5}{f_A L_A}\right)^{\frac{1}{2}} + \left(\frac{d_B^5}{f_B L_B}\right)^{\frac{1}{2}} + \ldots$
$\eta = \frac{P_f}{P}$	$F = \dot{m}(v_2 - v_1)$
$F_R = \sqrt{F_x^2 + F_y^2}$	$\theta = tan^{-1}\frac{F_y}{F_x}$

2. DENSITY & DYNAMIC VISCOSITY OF WATER

Temperature (°C)	Density (kg/m³)	Dynamic Viscosity (Pas)
0	1000	1.80×10^{-3}
5	1000	1.52×10^{-3}
10	1000	1.31×10^{-3}
15	999	1.15×10^{-3}
20	998	1.00×10^{-3}
25	997	0.90×10^{-3}
30	996	0.80×10^{-3}
35	994	0.72×10^{-3}
40	992	0.66×10^{-3}
45	990	0.60×10^{-3}
50	988	0.55×10^{-3}
55	986	0.51×10^{-3}
60	983	0.47×10^{-3}
65	980	0.44×10^{-3}
70	977	0.41×10^{-3}
75	974	0.38×10^{-3}
80	971	0.36×10^{-3}
85	968	0.34×10^{-3}
90	965	0.32×10^{-3}
95	962	0.30×10^{-3}
100	958	0.28×10^{-3}

3. K-FACTOR OF COMMON FITTING

FITTING/VALVE	CONDITION	K FACTOR
45° Elbow	Standard radius	0.3
90° Elbow	Standard radius	0.6
	Long radius	0.3
Return Bend		0.8
Socket or Coupler	Screwed type	0.03
Tee	Along line of flow	0.3
	Through side	0.8
Gate Valve	Fully open	0.2
	½ open	4.5
Globe Valve	Fully open	6.0
	¾ open	8.0
	½ open	12.0
	¼ open	24.0
Check Valve	Hinged or swing disc	1.7
	Ball or poppet type	4.0
Foot Valve with strainer	Hinged or swing disc	3.0
	Ball or poppet type	7.0
Gradual transition	Contracting	0 (negligible)
	Enlarging	0.75
Pipeline	Sudden contraction	0.25
	Sudden enlargement	1.0
Tank to pipeline	Sudden entrance	0.5
Pipeline to tank	Sudden exit	1.0

4. ABSOLUTE ROUGHNESS VALUES OF VARIOUS COMMON PIPE MATERIALS

Materials	Absolute Roughness, ε (mm)
Cast iron	0.25
Commercial steel/wrought iron	0.045
Galvanized iron/steel	0.15
Concrete (cast on steel forms)	0.20
Concrete (spun)	0.10
PVC and other drawn tubing	0.0015