CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
FEBRUARY 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	:	2.00 PM – 4.30 PM (2 HOURS 30 MINUTES)
DATE	:	26 JUNE 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 11 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

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

Question 1

With reference to buoyant force and Archimedes' principle:

(a) i. Define buoyant force.

(2 marks)

ii. Describe Archimedes' Principle.

(3 marks)

(b) A spherical shape underwater research chamber is anchored to the sea bottom by a cable as shown in Figure 1. The external diameter of the chamber is 5.5 m and has a mass of 34600 kg when occupied. The chamber is completely immersed in seawater of density 1020 kg/m^3. Calculate:

i. the volume of the chamber

(3 marks)

ii. the buoyant force that supports the chamber

(4 marks)

iii. the tension in the cable

(4 marks)

iv. the relative density of the chamber.

(4 marks)

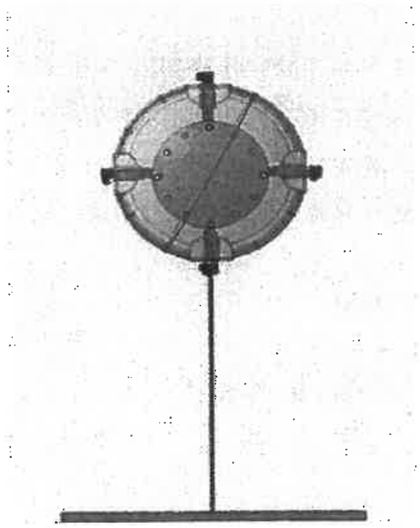

Figure 1

Question 2

With reference to fluid flow, Continuity Equation and Bernoulli's Equation:

(a) Figure 2 shows a water supply system with water flowing into pipes A and B and discharging from pipe D. The velocity of water entering pipe B is 5 m/s, while the velocity of water leaving pipe D is 3.75 m/s. The diameters of pipes A, B, and D are 90 mm, 50 mm, and 80 mm, respectively. Determine:

i. volume flow rate in pipe D

(3 marks)

ii. the velocity of water in pipe A

(4 marks)

iii. the diameter of pipe C if the velocity is 0.6 m/s

(3 marks)

iv. the mass flow rate of the system if the density of water is 995 kg/m^3.

(3 marks)

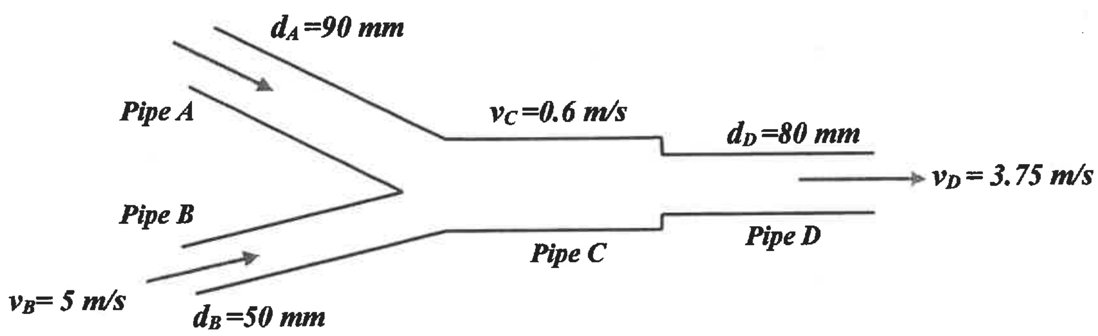

Figure 2

(b) A liquid flow through an inlet pipe at a speed of 0.72 m/s at the ground level. The diameter at the inlet is 10 cm and the pipe rises 8 m in height at the outlet, where the pipe tapers to 5 cm. The pressure at the outlet is atmospheric (zero-gauge pressure). If the density of the liquid is 900 kg/m^3, calculate:

i. the speed at the outlet

(3 marks)

ii. the gauge pressure at the inlet.

(4 marks)

SECTION B (Total: 60 marks)

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

Question 3

With reference to losses in horizontal pipe.

Diesel fuel is pumped at a rate of 240 L/min through a PVC pipe of diameter 150 mm and length 1 km. 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

(8 marks)

(b) the friction factor

(6 marks)

(c) the pressure drops due to head loss

(6 marks)

Question 4

With reference to head loss due to fittings.

A piping system in Figure 3 is used to transfer water at 20°C from the lower tank to the upper tank using a pump at a rate of 4 m/s. The diameter of the pipe is 100 mm and the total length of the piping system is 500 m. The gauge pressure at the upper tank is 80 kPa and it is 4.5 m above the surface of water in the lower tank. Given that the friction factor of the pipe is 0.039, determine:

(a) the K factors for all fitting

(7 marks)

(b) the head loss in a system

(4 marks)

(c) the system head

(4 marks)

(d) the fluid power.

(5 marks)

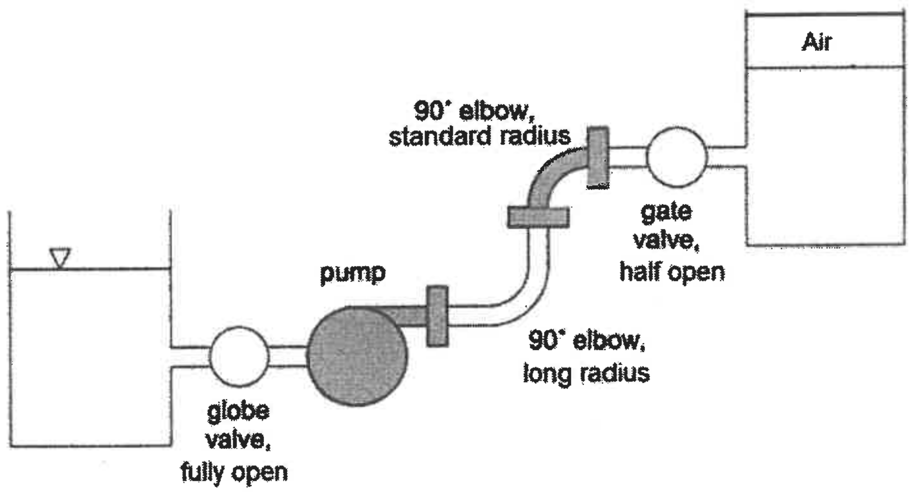

Figure 3

Question 5

With reference to head loss in a parallel pipe:

A pipe network consists of four pipes that are connected as in Figure 4. The relative roughness of the pipe is 2.25×10^{-4}. Water at 30°C flows in the system and the length and diameters of the pipes are listed below. Given that the velocity of the water in pipe P is 1.91 m/s.

Pipe	Length (km)	Diameter (mm)
P	3.0	200
Q	2.2	300
R	3.2	200
S	2.8	400

a) Calculate the friction factor of pipe P.

(6 marks)

b) Determine the head loss between point 1 and 2. (Assume that the friction factor is constant for all pipes.)

(14 marks)

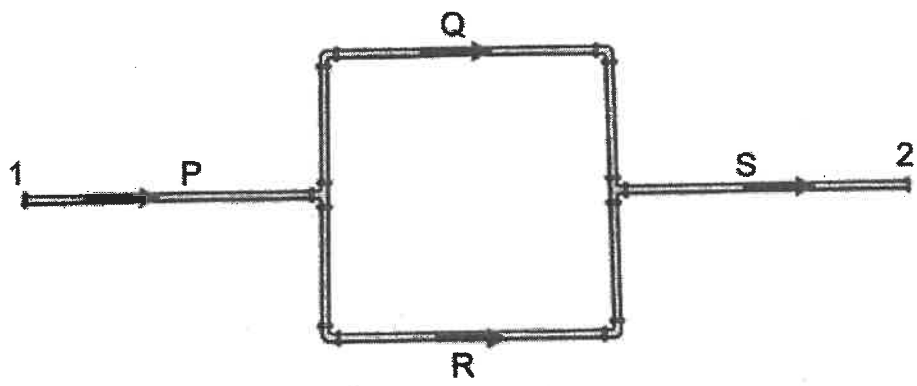

Figure 4

Question 6

With reference to fluid force:

A steam jet of 50 mm in diameter is discharged from a nozzle with a velocity of 80 m/s strikes a curved turbine blade and deflected at an angle of 30° as in Figure 5. The specific volume of the fluid is 4.2 m³/kg. Calculate the magnitude and the direction of the force on the blade, if the turbine blade is moving away from the jet with a velocity of 10 m/s.

(20 marks)

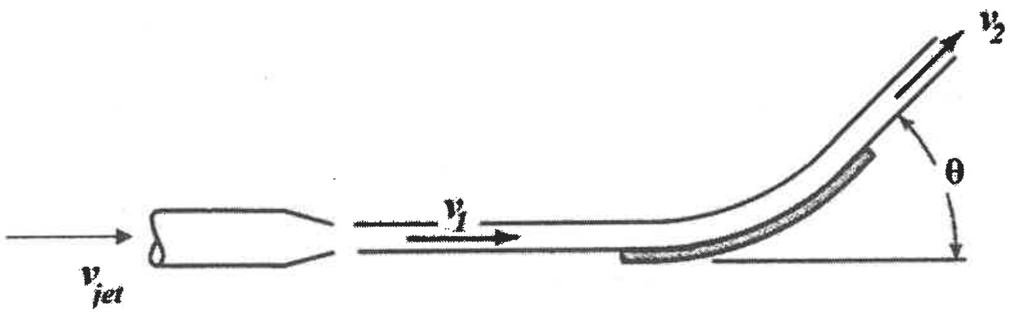

Figure 5

END OF EXAMINATION PAPER

APPENDICES

1. TABLE OF FORMULAE

$\rho = \frac{m}{V}$	$RD = \frac{\rho_{substance}}{\rho_{water}}$
$F_B = W_o$	$F_B = \rho_f V_f g$
$\dot{V} = Av$	$\dot{m} = \rho A v$
$P + \frac{1}{2}\rho v^2 + \rho g h = constant$	$h + \frac{P}{\rho g} + \frac{v^2}{2g} = constant$
$Re = \frac{vd}{\nu}$	$Re = \frac{\rho v d}{\mu}$
$f = \frac{64}{Re}$	$f = 0.0055\,[\,1 + (20000\varepsilon_R + \frac{10^6}{Re})^{\frac{1}{3}}\,]$
$\varepsilon_R = \frac{\varepsilon}{d}$	$\Delta P = \rho g H_L$
$H_L = \frac{fLv^2}{d2g}$	$H_L = \Sigma K \frac{v^2}{2g}$
$H_L = \left(\frac{fL}{d} + \Sigma K\right)\frac{v^2}{2g}$	$H_{stat} = \frac{P_2 - P_1}{\rho g} + (h_2 - h_1)$
$H_{dyn} = \frac{v_2^2 - v_1^2}{2g} + H_L$	$P_f = \dot{m} g H$
Series pipes: $\frac{f_E L_E}{d_E^5} = \frac{f_A L_A}{d_A^5} + \frac{f_B L_B}{d_B^5} + \dots$	*Parallel pipes:* $\left(\frac{d_E^5}{f_E L_E}\right)^{\frac{1}{2}} = \left(\frac{d_A^5}{f_A L_A}\right)^{\frac{1}{2}} + \left(\frac{d_B^5}{f_B L_B}\right)^{\frac{1}{2}} + \dots$
$\eta = \frac{P_f}{P}$	$F = \dot{m}(v_2 - v_1)$
$F_R = \sqrt{F_x^2 + F_y^2}$	$\theta = tan^{-1}\frac{F_y}{F_x}$

2. DENSITY & DYNAMIC VISCOSITY OF WATER

Temperature (°C)	Density (kg/m^3)	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