UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2016 SEMESTER

COURSE CODE	: LGB 21403
COURSE NAME	: FLUID MECHANICS
PROGRAMME NAME	: BACHELOR OF NAVAL ARCHITECTURE AND SHIP BUILDING
DATE	: 23 MAY 2016
TIME	: 02.00 PM – 05.00 PM
DURATION	: 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. Answer FOUR (4) questions ONLY.
4. Please write your answers on the answer booklet provided.
5. Answer should be written in blue or black ink except for sketching, graphic and illustration.
6. Answer all questions in English language ONLY.

THERE ARE 6 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 100 marks)

INSTRUCTION: Answer only FOUR questions.
Please use the answer booklet provided.

Question 1

(a) A pipeline carrying oil is at an elevation of *y* (m) from a fixed datum. It is required to measure a pressure *p* in the pipeline using a mercury manometer. The system is as shown in Figure 1. The levels of mercury in the two limbs are measured with reference to the above datum and are *a* (m) and *b* (m) respectively. **Derive** an expression for the pressure *p*. If y = 4 m; a = 1 m; b = 1.2 m; specific gravity of oil = 0.8 and that of mercury is 13.6, **calculate** the pressure in kN/m^2.

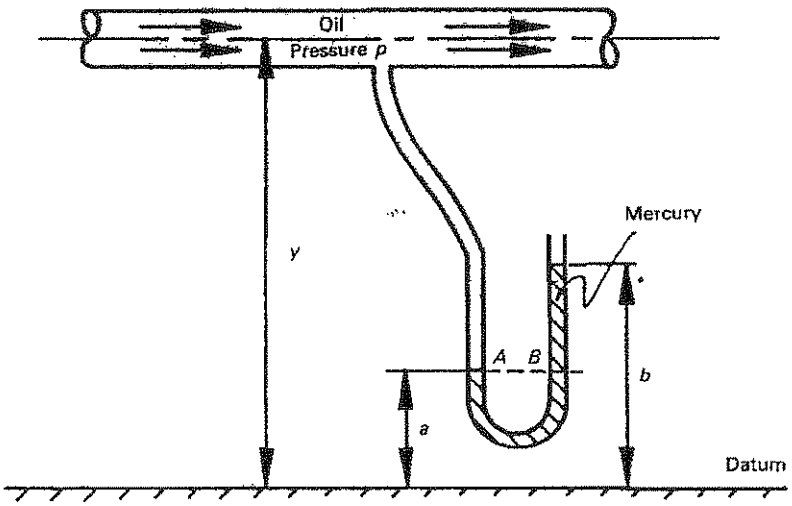

Figure 1: The U-tube manometer

(10 marks)

(b) In a city water supply system, water is pumped to a storage tank on a small hill, as shown in Figure 2. The pressure gauges at point 1 and 2 read 3.5 x 10^5 N/m^2 and 0.5 x 10^5 N/m^2 respectively. Neglecting all losses, **determine** the discharge through the pipeline. The diameter of pipe at 1 is 0.1 m and at 2 is 0.05 m.

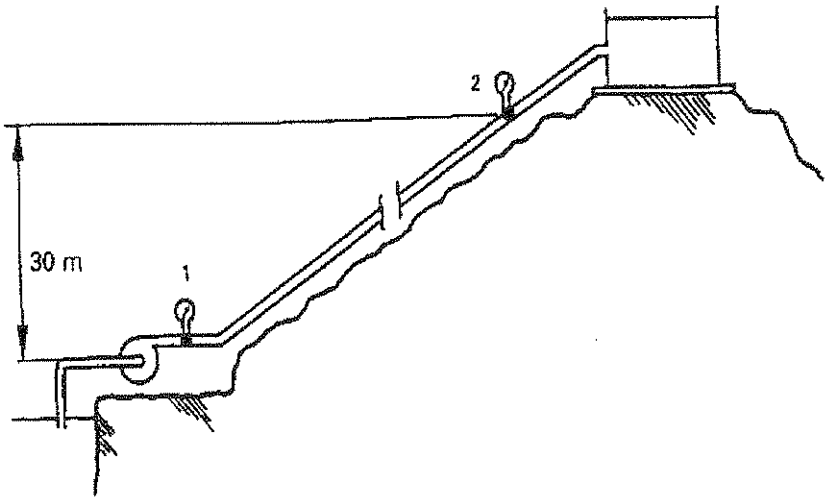

Figure 2: Water flow through a pipeline

(15 marks)

Question 2

(a) Oil with a specific gravity of 0.85 and a dynamic viscosity of 0.044 kg/ms is flowing in a 25 mm diameter pipe 120 m long at a rate of 55.1 L/min. **Calculate:**

i. the flow regime; and

(5 marks)

ii. the pressure drop.

(5 marks)

(b) Water is discharged from a reservoir into the atmosphere through a pipe 80 *m* long. There is a sharp entrance to the pipe and the diameter is 250 *mm* for the first 50 *m*. The pipe then enlarges suddenly to 450 *mm* in diameter for the remainder of its length. The outlet is 35 *m* below the surface level in the reservoir. **Determine** the discharge. Take f = 0.004 for both pipes. Consider all losses and utilize ***Darcy's Formula (British Version)*** for the major loss.

(15 marks)

Question 3

(a) The bottom surface of a plastic boat (width = 1.5 m and length = 2 m) as shown in Figure 3 is approximated as a flat and smooth surface. **Analyze** the friction drag on the bottom surface of the boat by water and the power needed to overcome it. Assume the flow is steady and incompressible, the water is calm (no significant of current or waves) and the water flow is turbulence over the entire surface because of the constant agitation of the boat. The density and dynamic viscosity of water at 15°C are 999.1 kg/m^3 and 1.138 x 10^{-3} kg/ms respectively.

Figure 3

(12 marks)

(b) A submarine is treated as an ellipsoid at a specified length and diameter as shown in Figure 4. **Determine** the powers required for this submarine to cruise horizontally in seawater and to tow it in air. Assume the flow is turbulent, the drag of the towing rope is negligible and the motion of submarine is steady and horizontal. The drag coefficient for an ellipsoid with L/D = 25/5 = 5 is CD = 0.1. The density of sea water is given to be 1025 kg/m^3 and the density of air is given to be 1.30 kg/m^3.

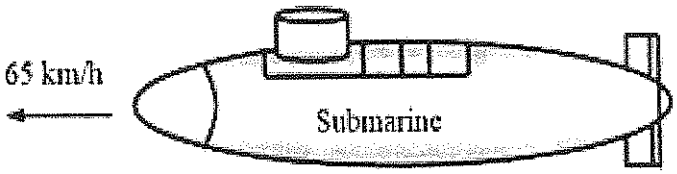

Figure 4

(13 marks)

Question 4

(a) A cylinder of circular section, diameter *d*, made of material which specific gravity is *S*, floats in a liquid of specific gravity S_O as shown in Figure 5. **Examine** the maximum length of cylinder if the axis is to remain vertical.

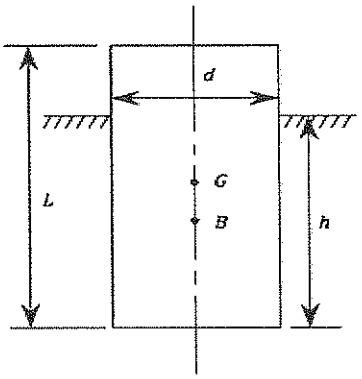

Figure 5

(10 marks)

(b) A rectangular pontoon is 6 m long, 4 m width and 3 m height as shown in Figure 6. Its mass is 20 tonnes and its centre of gravity, CG is 1 m from the bottom along the centerline of the mid-section of the pontoon. If the pontoon is floating in fresh water, **evaluate** the metacentric height of the pontoon.

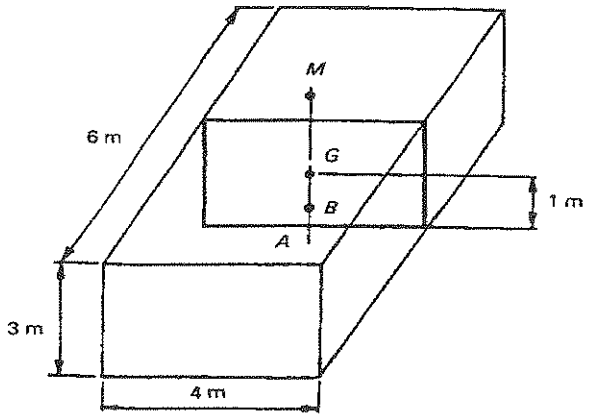

Figure 6

(15 marks)

Question 5

(a) **Compare** Centrifugal Pump and Reciprocating Pump.

(8 marks)

(b) **Define** Priming of a Centrifugal Pump.

(3 marks)

(c) A pump delivers 50 L/s of water with a head of 55 m and runs at a speed of 1470 rpm for 8 hours per day. The efficiency is 78%. The electric motor driving the pump has an efficiency of 88% and the cost of electricity is 10.5 cents per kWh. **Evaluate**:

i. the shaft power;

(4 marks)

ii. the shaft torque;

(5 marks)

iii. the cost of electricity per day to run the pump.

(5 marks)

END OF EXAMINATION PAPERS

Appendix 1: List of Common Formulas

$\mathrm{Re} = \frac{\rho v d}{\mu}$	$\mathrm{NPSHA} = \frac{p_i - p_v}{\rho g} + \frac{v^2}{2g}$
$\mathrm{Re} = \frac{vd}{\upsilon}$	$\eta = \frac{P}{P_f}$
$h_f = \frac{fLv^2}{2gd}$	$\eta = \frac{P_f}{P}$
$h_L = K\frac{v^2}{2g}$	$\mathrm{NPSHA} = \frac{p_1 - p_v}{\rho g} - h - H_L$
f = 64/Re	$N_s = \frac{N\sqrt{P}}{H^{5/4}}$
$f = 0.0055\left[1 + \left(20000_{\varepsilon_R} + 10^6/\mathrm{Re}\right)^{1/3}\right]$	BG = CG - CB
$H_L = \left(fL/d + \Sigma K\right)\frac{v^2}{2g}$	$BM = \frac{I}{V_d}$
$L_E = Kd/f$	$GM = BM \pm BG$
$\frac{f_E L_E}{d_E{}^5} = \frac{f_A L_A}{d_A{}^5} + \frac{f_B L_B}{d_B{}^5} + \ldots\ldots$	$C_D = \frac{F_D}{\frac{1}{2}\rho u^2 A}$
$\left(\frac{d_E{}^5}{f_E L_E}\right)^{1/2} = \left(\frac{d_A{}^5}{f_A L_A}\right)^{1/2} + \left(\frac{d_B{}^5}{f_B L_B}\right)^{1/2} + \ldots\ldots$	$C_L = \frac{F_L}{\frac{1}{2}\rho u^2 A}$