NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

FLUID MECHANICS

TCW 2101

Main Examination Paper

DECEMBER 2016

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: NONE

Examiner's Name: DR. EUGINE MAKAYA

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

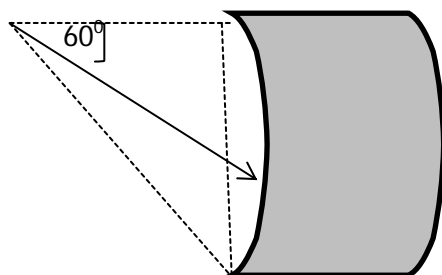| QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
TOTAL	100

QUESTION 1

(a) What will be (i) the gauge pressure and (ii) the absolute pressure of water at depth 12m below the surface? Density of water = 1000kg/m^3, and P$_{Atmosphere}$ = 101kN/m^2.

(4 marks)

(b) At what depth below the surface of oil, relative density 0.8, will produce a pressure of 120 kN/m^2 ? What depth of water is this equivalent to?

(5 marks)

(c) A differential "U"-tube manometer containing mercury of density 13000kg/m^3 is used to measure the pressure drop along a horizontal pipe. If the fluid in the pipe is water and the manometer reading is 0.6m, what is the pressure difference between the two tapping points?

(10 marks)

(d) A hydraulic jack having a ram of 150 mm in diameter lifts a weight of 20kN under the action of a 30mm diameter plunger. The stroke length of the plunger is 250mm and if it makes 100 strokes per minute, find how much load is lifted per minute and what power is required to drive the plunger

(6 marks)

QUESTION 2

(a) A flat circular plate 1.25m diameter is immersed in water such that its greatest depths are 1.5m and 0.60m respectively.

(i) Determine the force exerted on one face by the water pressure

(6 marks)

(ii) Determine the position of the centre of pressure   (8 marks)
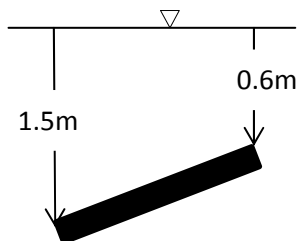
(b) The profile of a masonry dam is an arc of a circle, the arc having a radius of 30m and subtending an angle of 60^0 at the centre of curvature which lies in the water surface.
(i) Determine the load on the dam in N/m length   (7 marks)
(ii) Determine the position of the line of action to this pressure.   (8 marks)

QUESTION 3

(a)   A dock gate 10m wide has sea depths of 6m and 15m on its sides respectively. The relative density of sea water is 1.03.

(i)   Calculate the resultant force acting on the gate due to the water pressure
                                                                                    (7 marks)

(ii)   Find the position of the centre of pressure relative to the bottom of the gate
                                                                                    (8 marks)

(b)   Consider a horizontal nozzle discharging into the atmosphere. The inlet has a bore area of 60mm^2 and the exit has a bore area of 200mm^2. Calculate the flow ratewhen the inlet pressure is 400Pa, assuming no energy losses. (10 marks)

QUESTION 4

(a)   A 2 m x 2 m tank with vertical sides contains oil of density 900 kg/m^3 to a depth of 0.8 m floating on 1.2 m depth of water.

   (i)   Calculate the total thrust and its location on one side of the tank
                                                                                    (10 marks)

   (ii) Determine also the force on the base of the tank and comment on its relationship with the weight of the water and oil.   (5 marks)

(b)   A lock gate is of rectangular section 7.2 m wide. The depth of water on the lower side is 2.4 and the depth on the opposite side is h m. The maximum allowable resultant thrust is 1.5MN. Calculate the maximum value of h if this thrust is not to be exceeded.   (10 marks)

QUESTION 5

(a)   A pipeline carries water around a horizontal 45^0 bend. The entrance diameter of the bend is 500mm and the velocity of flow is 1 m/s. The bend tapers gradually to 200 mm diameter at its exit. If the pressure just upstream of the entrance is measured at 200kN/m^2, what is the force, and its line of action, exerted by the water on the bend?   (15 marks)

(b)   Calculate the force required to hold a firehose for a discharge of 5 l/s if the nozzle has an inlet diameter of 75 mm and an outlet diameter of 25 mm.
                                                                                    (10 marks)

END OF EXAMINATION