NATIONALUNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial and Manufacturing Engineering

2nd Semester Main Examination

COURSE	**:**	**FLUID MECHANICS**
CODE	**:**	**TIE 2202**
DATE	**:**	**APRIL/MAY 2014**
DURATION	**:**	**3 HOURS**

INSTRUCTIONS AND INFORMATION FOR THE CANDIDATE

1. Answer any **five (5) questions**
2. All questions carry **20 marks** each
3. This paper contains seven**(7)** questions
4. There are four **(4)** printed pages

REQUIREMENTS

1. Scientific calculator

QUESTION 1

(a) Explain the major differences between fluids and solids, and between liquids and gases [6]

(b) Discuss the differences between Newtonian fluids and the various classes of non-Newtonian fluids [6]

(c) Figure Q1c shows a cross section of a triangular dam wall. Given that the dam wall is inclined at 60° ($\theta = 60^o$), the length of the dam wall is 30.5 m ($L = 30.5\ m$) and the depth of the dam is 8 m ($h = 8\ m$). Calculate the resultant force and its location. [8]

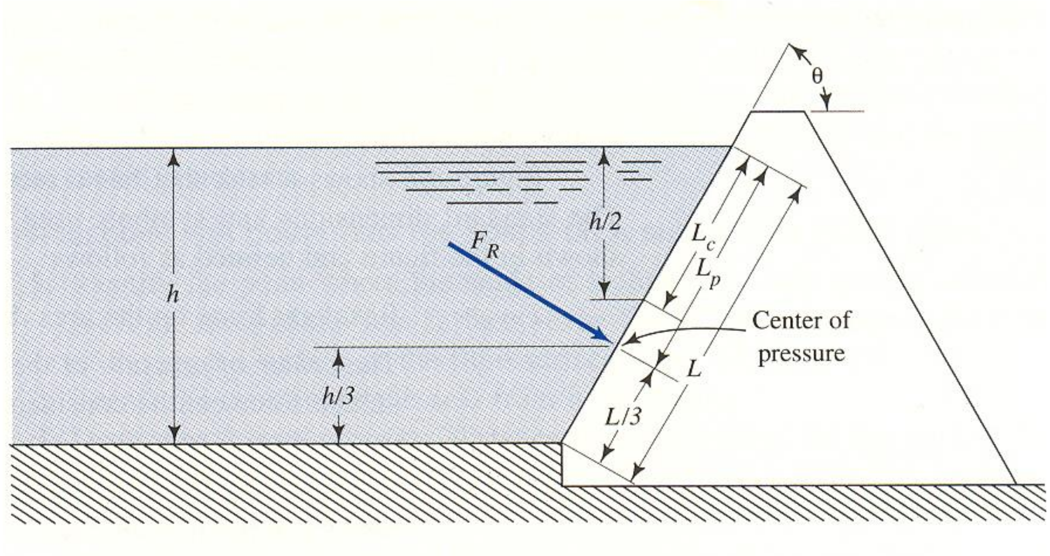

Figure Q1c: Cross section of triangular dam wall

QUESTION 2

At a car wash a jet of water 20 mm in diameter, moving with a velocity of 10 m/s, strikes a flat surface of a car at an angle of 30° to the normal of the car surface. If the car itself is moving with a velocity of 2 m/s and in the direction of the normal to the car surface,

Calculate:

(a) The normal force exerted on the flat surface of the car, [6]

(b) The work done per second, [8]

(c) The efficiency. [6]

QUESTION 3

(a) Differentiate between lamina and turbulent flow. [2]

(b) In a casting setup molten iron flows into a mould cavity through a cylindrical sprue AB of diameter 70 mm, which is in series with another sprue BC of diameter 40 mm in which the velocity is 2 m/s. At C the sprue forks into two runners and one branch CD is of unknown diameter such that the velocity is 1.5 m/s. The other branch CE is of diameter 25 mm and conditions are such that the discharge in sprue BC divides such that the discharge in the runner CD is equal to two times the discharge in runner CE. The two runners CD and CE run into two separate mould cavities that have a void of 3.5 litres and 2.0 litres respectively. Calculate the following flow parameters assuming incompressible flow and neglecting the effect of gravity on the flow:

(i) Discharge in sprue AB [3]

(ii) Discharge in runner CD [3]

(iii) Velocity in sprue AB [3]

(iv) Velocity in runner CE [3]

(v) Diameter of runner CD [3]

(vi) The filling time of the two mould cavities [3]

QUESTION 4

(a) The space between two large flat and parallel walls 25 mm apart is filled with a liquid of absolute viscosity 0.7 Pas. Within this space a thin flat plate 250 mm x 250 mm is towed at a velocity of 150 mm/s at a distance 6mm from the wall, the plate and its movement being parallel to the walls assuming linear variations of velocity between the plate and the walls, determine the force exerted by the liquid on the plate. [5]

(b) (i) A venturi tube tapers from 250 mm in diameter at the entrance to 75mm in diameter, at the throat, and the discharge coefficient is 0.95. A differential mercury U-tube manometer gauge is connected between pressure tapings at the entrance and the throat. If the meter is used to measure the flow of water and the water fills the leads to the U-Tube manometer and is in contact with mercury. Calculate the discharge when the difference of level in the U-tube manometer is 33 mm. [10]

(ii) Derive an expression for measuring the velocity of flow using a Pitot tube [5]

QUESTION 5

A pipeline carries water at the rate of $2.5m^3/s$ from one reservoir to another that is 4 km away and 45 m lower. The diameter of the pipe is 30 mm. Assume that the friction factor for a smooth pipe is given by equation;

$$f = \frac{\tau_w}{\frac{1}{2}\rho u^2} = 0.046Re^{-0.20}$$

Where τ_w is the wall shear stress, ρ is the density, u is the mean velocity in the pipe and Re is the Reynolds number, and for water the density is $1000kg/m^3$ and the dynamic viscosity is 1.0×10^{-3}Pa s

What will be the power required to maintain flow ? [20]

QUESTION 6

(a) A 45° reducing pipe bend in a horizontal plane tapers from 400mm diameter at inlet to 200mm diameter at outlet the gauge pressure at inlet is 120kPa and the rate of flow of water through the bend is $0.425m^3/s$. Neglecting friction, Calculate the net resultant force exerted by the water on the bend. [12]

(b) Derive from first principles Bernoulli's equation for frictionless, incompressible flow through a pipe and explain the terms in the equation. [8]

QUESTION 7

Two pipes connect two reservoirs (A and B) which have a height difference of 15m. Pipe 1 has diameter 50mm and length 100 m. Pipe 2 has diameter 100 mm and length 100 m. Both have entry loss $kL = 0.5$ and exit loss $kL = 1.0$ and Darcy f of 0.008.

Calculate:

(a) rate of flow for each pipe [8]

(b) the diameter D of a pipe 100m long that could replace the two pipes and provide the same flow. [12]

End of Examination