NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial & Manufacturing Engineering

Fluid Mechanics – TIE 2202

2nd SEMESTER EXAMINATIONS AUGUST, 2009

INSTRUCTIONS TO CANDIDATES

Time : 3 hours

Answer 5 questions

QUESTION .1

a) Derive the equation of continuity for fluid flow. [10]

b) Define the following terms used in connection with the flow of a Liquid

i) uniform flow [2]
ii) steady flow [2]
iii) unsteady flow [2]
iv) discharge [2]
v) mass flow rate [10]

QUESTION 2

Derive Bernoulli's equation for the flow of an incompressible frictionless fluid from the consideration of momentum. [20]

QUESTION 3

Water flows through a pipe AB diameter whose diameter is 1.2m at 3m/s and then passes through a pipe BC, 1.5m in diameter. At C the pipe fork, branch CD is 0.8m in diameter and carries one third of the flow in AB. The velocity in branch CE is 2.5m/s

Find:

a) the volume rate of flow in AB [5]
b) the velocity in BC [5]
c) the velocity in CD [5]
d) the diameter of CE [5]

QUESTION 4

a) Summarise the objectives of the eight chapters that have been covered in Fluid Mechanics. [12]

b) Discuss the implication of the momentum equation as far as fluid flow is concerned . [8]

QUESTION 5

a) A pipe line carries water at the rate of $1.5m^3/s$ from 1 reservoir to another which is 3km away and 45m lower. The diameter of the pipe is 40mm. Assume that the friction factor for a smooth pipe is given by

$$f = \frac{\tau w}{\frac{1}{2}\rho u^2} = 0.046\,\mathrm{Re}^{-0.2}$$

Where τw is the wall shear stress, ρ is density, u is the mean velocity in the pipe and Re is the Reynolds number, and for water the density is 1000 $kg/_m{}^3$ and the dynamic viscosity is $1.0x10^{-3}Ns/m^2$. What will be the power required to maintain flow? [10]

b) Show that from Euler's equation for the energy transfer between impeller and fluid the head is given by:

$$E= (U/g)(u-V_f \operatorname{Cos} \beta^1{}_2)$$ [10]

QUESTION 6

Show that in a fully developed laminar flow of a fluid through a pipe of radius *r* and length *L*, the velocity profile and the flow rate are given by:

(a) [10]

$$\mu = -\frac{R^2}{4\mu}\left(\frac{\partial p}{\partial x}\right)\left[1-\left(\frac{r}{R}\right)^2\right]$$

(b) [10]

$$Q = \frac{\prod \Delta p\, D^4}{128\mu L}$$

QUESTION 7

A 45° reducing pipe bend in a horizontal plane tapers from 600mm diameter at inlet to 300mm diameter at outlet. The gauge pressure at inlet is 140kPa 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. [20]

QUESTION 8

(a) Define the following terms in relation to boundary layer theory.

(i) Boundary layer thickness σ [2]

(ii) Displacement thickness σ* [2]

(iii) Momentum thickness [2]

(b) In a two dimension, laminar boundary layer flow along a flat plate, boundary layer velocity profile is

$$\frac{u}{U} = \sin\left(\frac{\Pi}{2}\frac{y}{\sigma}\right) \quad for\ 0 \le y \le \sigma$$

$$and\ \frac{u}{\bigcup} = 1\ for\ y = \sigma$$

Find:

(i) δ(x) disturbance thickness [4]

(ii) δ*(x) displacement thickness [5]

(iii) Total frictional force on a plate of length L, and width, b. [5]

END OF EXAM