NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

HYDRAULICS

TCW 3101

Supplementary Examination Paper

DECEMBER 2016

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph paper

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) Water at 10°C flows in a 6-m-wide rectangular channel at a depth of 0.55 m and a flow rate of 12 m^3/s.

(i) Determine the critical depth

(ii)Show whether the flow is subcritical or supercritical

(iii)Calculate the alternate depth

(15 marks)

(b) Water at 20°C flows in a partially full 2-m-diameter circular channel at an average velocity of 2m/s.(ρ = 998kg/m^3, μ = 1.307x10^{-3}kg/m.s). If the maximum water depth is 0.5m.

(i) Determine the hydraulic radius
(ii) Reynolds number
(iii) Determine the flow regime

(10 marks)

QUESTION 2

(a) Derive the Hagen – Poiseuille equation, $\frac{dV}{dt} = \frac{\pi \Delta P R^4}{128 \eta L}$ (10 marks)

(b) Two pipes connect two reservoirs (A and B) which have a height difference of 10m. Pipe 1 has a diameter of 50mm and length 100.m Pipe 2 has a diameter 1000mm and length 100m. Both have entry loss k_L = 0.5 and exit loss K_L = 1.0 and friction factor f =0.008. Calculate the rate of flow for each pipe (15 marks)

QUESTION 3

(a) Explain two factors that affect minor losses in pipeline systems (4 marks)

(b) A pipe carrying water experiences a sudden reduction in the area. The inlet area is 0.002m^2 and the outlet area is 0.001m^2. The pressure at outlet is 500kPa and the velocity is 8m/s. the loss coefficient K is 0.4. The density is 1000kg/m^3 Calculate (i) the flow rate (ii) inlet pressure and the force acting on the section

(21 marks)

QUESTION 4

(a) Distinguish between dynamic viscosity and kinematic viscosity (4 marks)

(b) Water of density ρ = 900kg/m^3, and kinematic viscosity ν = 0.0002m^2/s flows upward through a pipe inclined at 40° to the horizontal. The pressure between two sections 10m apart are P_1 = 350kPa and P_2 = 250kPa. Assuming steady laminar flow;
(i) Verify that the flow is up the incline
(ii) Calculate the head loss between the two points,

(iii) If the average flow velocity is 2.7m/s, calculate the flow rate
(iv) Prove that the flow is laminar

(21 marks)

QUESTION 5

(a) With the aid of neat sketches distinguish between the centrifugal and axial flow pumps

(4 marks)

(b) Describe a method which can be used to prevent cavitation in a pump

(3 marks)

(c) A water pump was tested at a rotation of 1500rpm. The following data was obtained

Q (L/s)	0	10	20	30	40	50
H (m)	10	10.5	10.0	8.5	6.0	2.5
Π	0.0	0.40	0.64	0.72	0.64	0.40

(Q is the quantity of flow, H is the head of water, Π is efficiency)

It is proposed to use this pump to draw water from an open sump to an elevation 5.5m above. The delivery pipe is 20m long and 100mm diameter and has a friction factor of 0.005

If operating at 1500rpm, find:

(i) The maximum discharge that the pump can provide

(ii) The pump efficiency at this discharge

(iii) The input power required

(10 marks)

(d) A pump lifts water from a large tank at a rate of 30L/s. If the input power is 10kW and the pump is operating at an efficiency of 40%, find:

(i) The head developed across the pump

(ii) The maximum height to which it can raise water if the delivery pipe is vertical, with diameter 100mm and friction factor $\lambda = 0.015$

(8 marks)

END OF EXAMINATION