NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

HYDRAULICS

TCW 3101

Main 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

Figure below shows a rectangular channel of width b = 5m carrying a flow Q = $60m^3/s$. A hydraulic jump with conjugate depths y_1 and y_2 occurs up stream of a 0.25m high broad crested weir.

(i) Determine the critical velocity V_c for this flow (6 marks)

(ii) If the depth over the weir is the critical depth, y_c determine the depth of flow at section 2, y_2 assuming no energy losses between section 2 and section 3 (7 marks)

(iii) Determine the alternate y_1 of the hydraulic jump using the value of y_2 above. (7 marks)

(iv) Calculate the head loss across the jump (5marks)

QUESTION 2

(a) The normal depth of flow in a trapezoidal concrete lined channel is 2 m. The channel base width is 5 m and has side slopes of 1:2. Manning's n is 0.015 and the bed slope is 0.001; $\mu=1.14x10^{-3}$. Determine the following

(i) Discharge

(ii) Mean velocity

(iii) Reynolds number

(6 marks)

(b) If the discharge in the channel is $30m^3/s$, find the normal depth of flow

(6 marks)

(c) During large floods, the water level in the channel exceeds the bank level. The flood channels are 10m wide and have side slopes of 1:3 and the Manning's n is 0.035. Find the discharge for a flood level of 4m and the energy coefficient (13marks)

QUESTION 3

An open channel has a trapezoidal cross section with sides inclined at 45^o to the vertical. The channel must carry $21m^3/s$ with a velocity of 3m/s with minimum friction.The constant n in the manning is 0.012

(a) Determine the smallest slope of the bed for these conditions and the corresponding depth dimensions of the channel. (10 marks)

(b) Show that the flow is subcritical (5 marks)

(c) 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 4

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.

(i) Calculate the rate of flow for each pipe (10 marks)

(ii) the diameter of a pipe 100m long that could replace the 2 pipes and provide the same flow. (15 marks)

QUESTION 5

A centrifugal pump is required to produce a flow of water at a rate of $0.016m^3/s$ against a total head of 30.5m. The operating characteristics of the pump at a speed of 1430rpm and a rotor diameter of 125mm is as follows

Q_A (L/s)	0	0.0148	0.0295	0.0441	0.059
H_A (m)	68.6	72	68.6	63.4	22.8
Ƞ	0	48	66	66	45

(a) Determine the correct size of pump and its speed to produce the required head and flow (15 marks)

(b) 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 factorλ = 0.015 (10 marks)

END OF EXAMINATION