NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

HYDRAULICS

TCW 3101

Supplementary Examinations paper

September 2015

This examination paper consists of 5 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements:

Examiner's Name: Mrs S. Nhandara

INSTRUCTIONS

1. Answer ALL questions
2. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1	25
2	25
3	25
4	25
TOTAL	100

QUESTION 1

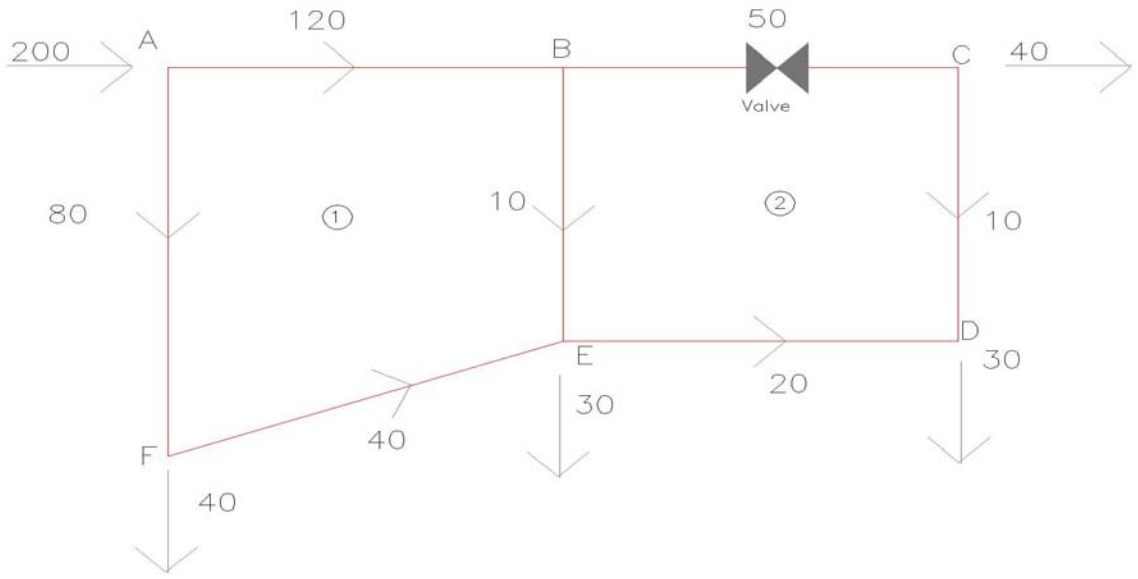
a. Distinguish between energy grade lines and hydraulic grade lines (4 marks)

b. A 200mm dia, pipeline 5000m long and of effective roughness 0.03mm delivers water between reservoirs the minimum difference in water level between which is 40m.

i. Taking only friction, entry and velocity head losses into account, determine the steady discharge between the reservoirs

ii. If the discharge is to be increased to 50l/s without increase in gross head determine the length of 200mm diameter pipeline of effective roughness 0.015mm to be fitted in the parallel. Consider only friction losses (9 marks)

c. In the network shown a valve BC is partially closed to produce a local head loss of $10.0V_{BC}^2/2g$. Analyse the flows in the network



Roughness of all pipes = 0.06mm

Pipe	AB	BC	CD	DE	BE	EF	AF
Length (m)	500	400	200	400	200	600	300
Diameter (mm)	250	150	100	150	150	200	250

(12 marks)

[25 marks]

QUESTION 2

a. i. Define the term development length and explain its significance (5 marks)

ii. $v_{water} = 1.0x10^{-6.}$ Calculate the Reynolds numbers for average velocity 0.5 m/s in pipes of inside diameter 12 mm and 0.3 m. Find the development length in each case.

(10 marks)

b. The outflow from a pipeline is 30 L/s. The pipe diameter is 150 mm, length 500 m and roughness estimated at 0.06 mm. Find the head loss along the pipe.

(10marks)

[25 marks]

QUESTION 3

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 30 m^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 4

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
η	0.0	0.40	0.64	0.72	0.64	0.40

(Q is the quantity of flow, H is the head of water, η 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 ana 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)

[25 marks]

List of equations

Colebrook-White equation:

$$1/\lambda^{1/2} = -2\log\left[k/3.7D + 2.51/(Re\ \lambda^{1/2})\right]$$

Colebrook-White - Darcy-Weisbach equation

$$v = -2(2gDs_f)^{1/2}.\ \log[k/3.7D + 2.51v/D(2gDs_f)^{1/2}]$$

Hazen-Williams equation

$$v = 0.85C_{HW}R_h^{0.63}S^{0.54}$$