GX2449

Ollscoil na hÉireann, Gaillimh

SUMMER EXAMINATION 2000

(International Postgraduate Hydrology Courses)

Postgraduate Diploma in Hydrology

HYDRAULICS

Examiners: Prof. P. E. O'Connell
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Time allowed: **Three Hours**.
Attempt any ***Five*** Questions.

1. **(a)** In the context of pipe flow hydraulics, what you understand by the following terms:

(i) Bulk Modulus;
(ii) cavitation;
(iii) Water Hammer;
(iv) Coefficient of discharge;
(v) Transitional Turbulent Flow.

(10 marks)

(b) In the context of open channel flow hydraulics, what you understand by the following terms:

(i) St. Venant Equations;
(ii) Positive Surge Wave
(iii) Method of characteristics
(iv) Celerity;
(v) Hydrological Routing.

(10 marks)

2. **(a)** Water is flowing at a discharge of 2 m^3/s in a channel of triangular cross-section. The channel side slopes are at 45° and the flow depth is 2.5m.

Calculate: the Froude number; hydraulic depth; and alternate depth.

(6 marks)

(b) A trapezoidal channel has a 3m wide base and sides sloping at 45°. The channel conveys a discharge of 23 m^3/s at a uniform depth of 3m.

The channel has a local constriction formed by raising the sides to a vertical position.

Calculate the depth of water in the constriction, neglecting local head losses.

What is the minimum height of a hump that could be installed in the constriction to produce critical depth there?

(14 marks)

3. **(a)** Indicate what you understand by the following terms related to open channel flow.

(i) Control sections
(ii) Water surface profile classification
(iii) Conveyance

(6 marks)

(b) An hydraulic jump is observed in a channel of triangular cross-section with sides at 45°. The depths upstream and downstream of the jump are 0.9m and 1.2m respectively.

Estimate the discharge in the channel.

(6 marks)

(c) There is a change of slope from 0.005 to 0.006 in a long channel which can be considered wide. The normal depth for the upstream region is 1.5m and Manning's n is 0.015 throughout the channel.

Find the depth of flow at the cross-section where the slope changes, showing all calculations and explaining your reasons.

(8 marks)

4. **(a)** It is proposed to construct a 20km long, 400mm diameter rising main to supply water from a lake whose water surface level is 10m O.D. to a regional storage reservoir whose water surface level is 22m O.D.

Select which of the following two pumps is the most suitable in terms of reduced operating costs. In your calculation neglect shock losses and use a sand roughness coefficient k_s = 0.06mm.

Pump A Characteristic

Hm (m)	100.0	89.7	78.7	67.2	55.0	42.2	28.8
Q (m^3/s)	0.0	0.025	0.05	0.075	0.10	0.125	0.150
η (%)	0	30.6	52.5	65.6	70	65.6	52.5

Pump B Characteristic

Hm (m)	150.0	129.2	106.8	82.8	57.2	30.0	1.2
Q (m^3/s)	0.0	0.02	0.04	0.06	0.08	0.10	0.120
η (%)	0.0	38.86	62.2	70	62.2	38.86	0

(20 marks)

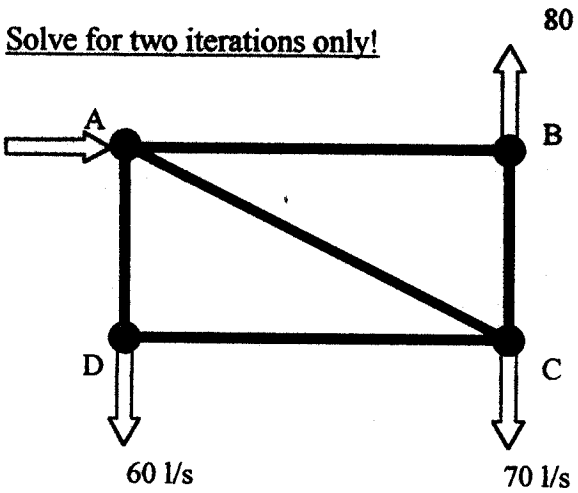
5. **(a)** Describe how the Hardy Cross solution method can incorporate the following pipe network items.

(i) Multiple Reservoirs
(ii) Branch pipes
(iii) Pumps

(6 marks)

(b) Using the Hardy Cross method, calculate the discharge in each pipe element for the pipe network shown in the accompanying diagram. Commence your solution by assuming an initial flow rate of 90 l/s in pipe AB and 20 l/s in pipe AD. Neglect all shock losses and assume a friction factor f = 0.02 fixed for all pipes.

Solve for two iterations only!



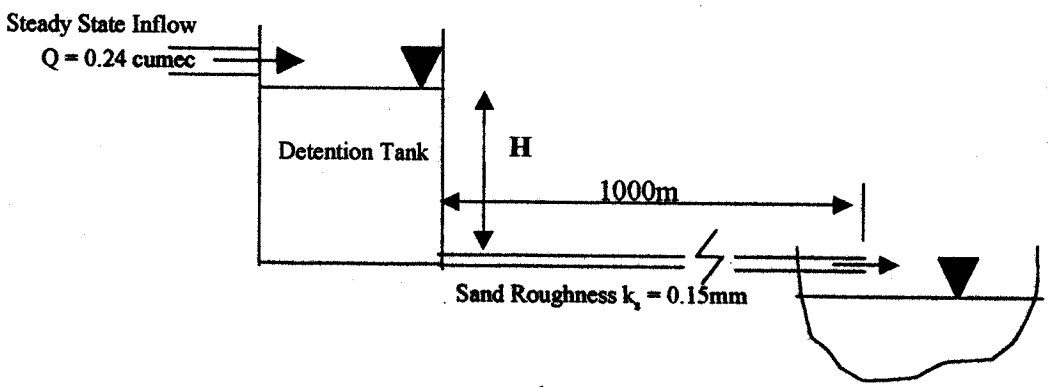
Pipe	Diameter	Length
AB	300mm	400m
BC	150mm	200m
AC	200mm	500m
CD	150mm	400m
AD	250mm	200m

(14 marks)

6. **(a)** Write an algorithm in <u>flow chart format</u> to calculate the optimum pipe diameter based on available commercial pipe sizes for a simple uniform pipeline which connects two reservoirs. Outline all relevant input data and relevant output results.

(6 marks)

(b) A steady state flow of 0.24 cumec enters a detention tank as shown in the accompanying diagram. If the water level in the detention tank H is not to exceed 10m, determine the minimum outlet pipe diameter required. The roughness coefficient k_s of the pipe is = 0.15mm.



(14 marks)