UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: October 2019

Module Number: CE5303 Module Name: Hydraulic Engineering

[Three Hours]

[Answer **all** questions, each question carries 12.5 marks]

Experimental values of Manning's n for different surfaces are provided

Q 1.

(i) What is meant by routing a flood along a river? State a practical use of doing such an exercise.

(02 Marks)

(ii) The Muskingum method models the storage volume of flooding in a river channel using a combination of wedge and prism storage. The key parameters in Muskingum routing are K (travel time) and α (weighting coefficient). Briefly explain how the Muskingum routing parameters are estimated.

(02 Marks)

(iii) Data given in Table Q1 refer to the inflow hydrograph for a certain reach of river which has values k = 0.75 days and α = 0.25 for Muskingum Coefficients. Equation (with standard notations) for a river reach outflow may be taken as;

$$O_2 = I_1C_0 + I_2C_1 + O_1C_2$$

where, $C_0 = (\Delta t + 2k\alpha)/(\Delta t + 2k - 2k\alpha)$

$C_1 = (\Delta t - 2k\alpha)/(\Delta t + 2k - 2k\alpha)$

$C_2 = (-\Delta t + 2k - 2k\alpha)/(\Delta t + 2k - 2k\alpha)$

Table Q1: Data related to Inflow Hydrograph

Time (hrs)	0	4	8	12	16	20	24
Discharge (m^3/s)	300	325	350	360	300	225	200

(a) Obtain the outflow hydrograph from this reach if the outflow at time = 0 is 200 m^3/s.

(b) Is it possible to have the outflow hydrograph in one (01) hour resolution with the available inflow data? Explain your answer.

(05+01 Marks)

(iv) Discuss application limitations associated with Muskingum method.

(2.5 Marks)

Q 2.

(i) Define the term 'specific energy'. Identify and explain the associated parameters of specific energy curve.

(02 Marks)

(ii) Consider the flow in a wide channel over a bump, as shown in Figure Q2.

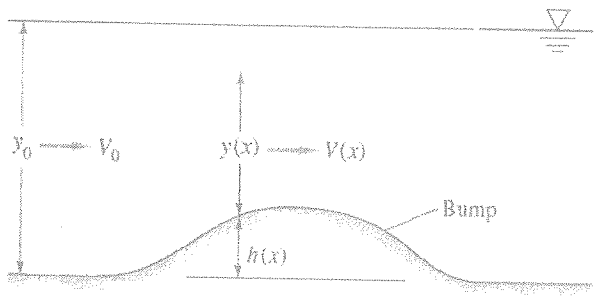

Figure Q2: Flow over a bump in a wide channel

Is the drawdown of the water surface realistic? Explain under what conditions the surface might rise above its upstream position y_0.

(04 Marks)

(iii) Water is flowing at 1.5 m/s in a wide brickwork channel with a bed slope angle of 0.0005 under uniform flow conditions. The flow encounters a 10 cm high frictionless smooth bump. Estimate;

(a) the Froude Number for approach condition.

(b) the depression or rise of the water surface profile over the bump.

(c) the bump height which will cause the crest flow to be critical.

(01+ 04 + 1.5 Marks)

Q3.

i) Briefly explain the significance of the following terms in relation to design of channels.

a) Maximum permissible velocity

b) Minimum permissible velocity

(02 Marks)

(ii) (a) Show that for a rectangular channel section, the most economical section is represented by $d = b/2$, where d and b are *depth* of flow and *width* of the canal section considered, respectively.

(02 Marks)

(b) The most economical section for a trapezoidal canal sections running partially full condition are half a hexagon. Prove this highlighting all the steps.

(04 Marks)

(c) What are the best dimensions for a rectangular concrete canal designed to carry $5m^3/s$ of water in uniform flow with $S_0 = 0.001$?

(02 Marks)

(d) Determine the flow rate for a half-hexagon section that would have same flowing area of above part (ii) (c).

(2.5 Marks)

Q4.

It is needed to convey water from a reservoir to an irrigation field. Two alternative options were suggested for this purpose. First alternative is a drilled rock tunnel through mountains with relatively shorter path. Second alternative is an open channel running around the hilly terrain. After investigation with a rigorous study of the topography/geology of the area, the second alternative has been selected.

(i) (a) Briefly explain the possible reasons for not selecting the first alternative.
(b) Suggest suitable hydraulic structure(s) for the canal when the trace is crossing natural hydrological drainage paths.

(02 + 02 Marks)

(ii) It has been suggested to use a rectangular canal with concrete as the lining material. The canal length is calculated as 20 km and the elevation difference between start and end point is 25 m. Uniform slope for the entire canal trace is proposed. Design the canal to convey 25 m^3/s. Canal design parameters are given in Table Q4.1 and Table Q4.2.

Table Q4.1: Recommendations for free board

Q (m^3/s)	< 0.75	0.75 ~ 1.5	1.5 ~ 8.5	> 8.5
Free board (m)	0.45	0.6	0.75	0.90

Table Q4.2: Permissible velocities

Canal material	Maximum Velocity (m/s)	Minimum Velocity (m/s)
For Stratified Rock	2.40	1.0
For Hard Rock	3.96	
For Concrete	4.57	

(06 Marks)

(iii) Briefly discuss the major hydrological design modification(s) to be adopted if the conveyance structure is designed as erodible earthen canal.

(2.5 Marks)

Experimental values of Manning's n for different surfaces

Type of surface	Manning's n
Artificial lined canals:	
Glass	0.010
Brass	0.011
Steel, smooth	0.012
Painted	0.014
Riverted	0.015
Cast iron	0.013
Cement, finished	0.012
Unfinished	0.014
Planed wood	0.012
Clay tile	0.014
Brickwork	0.015
Asphalt	0.018
Corrugated metal	0.022
Rubble masonry	0.025
Excavated earch canals:	
Clean	0.022
Gravelly	0.025
Weedy	0.030
Stony, cobbles	0.035
Natual channels:	
Clean and straight	0.030
Sluggish, deep pools	0.040
Major rivers	0.035
Floodplains:	
Pasture, farmland	0.035
Light brush	0.050
Heavy brush	0.075
Trees	0.150