UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: July 2017

Module Number: CE5303 Module Name: Hydraulic Engineering

[Three Hours]

[Answer **all** questions, each question carries 15 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) If I_1 and I_2 represent the inflow to a reach of river at the beginning and at the end of an interval of time and O_1 and O_2 represent the outflow from the reach at the corresponding instants, show that:

$$O_2 = I_1C_0 + I_2C_1 + O_1C_2$$

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

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

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

State the assumptions and identify the parameters represented by the symbols used.

(04 + 01 + 01 Marks)

(iii) The following data refer to the inflow hydrograph for a certain reach of river which has values k = 2/3 day and α = 0.25 for Muskingum Coefficients.

Time (hours)	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.

(c) The Muskingum method is not applicable when flow overtops the riverbanks and running in the flood plains. Comment on this statement.

(05 + 01 + 01 Marks)

Q 2.

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

a) Maximum permissible velocity
b) Minimum permissible velocity
c) Channel slope
d) Free board

(04 Marks)

(ii) For an earth channel of trapezoidal section show that the unit tractive force ratio may be taken as,

$$K = \tau_S / \tau_L = \cos\phi\sqrt{1-\frac{\tan^2\phi}{\tan^2\theta}}$$

Where, τ_S and τ_L refer to boundary shear strength on sloping sides and on level bed respectively when the motion of earth particles of the channel boundary at the respective region is impending.

(04 Marks)

(iii) Trapezoidal channel section with bed slope 1/600, side slopes 1 vertical to 2 horizontal, bed width 4.5 m and Manning's coefficient 0.030 conveys 65 m^3/s of water. The angle of friction of the channel bed materials may be taken as 35^0. Assume that τ_0 on sloping sides is 0.76 times that on the bed which will be taken as equal to the average tractive force on the entire cross section.

(a) If τ_L = 24.5 N/m^2, show that the channel is not stable against erosion on the tractive force criterion.

(b) Suggest a suitable design alteration to make the channel stable against erosion on the tractive force criterion.

(05 + 02 Marks)

Q 3.

(i) (a) What is meant by 'specific energy'? Define the related parameters of specific energy curve.

(b) Show that the relationship for the flow depth over a bump (with negligible frictional effects), in standard notations is represented by; $y_2^3 - E_2 y_2^2 + \frac{v_1^2 y_1^2}{2g} = 0$

where $E_2 = \frac{v_1^2}{2g} + y_1 - \Delta h$

(02 + 04 Marks)

Q 3. Continued to page 3.

(ii) Water flow in a wide channel approaches a 15-cm-high bump at 0.85 m/s velocity. If the approach depth of flow is 0.9 m,

(a) Verify that the water surface profile neither raises nor depresses at the top of the bump.

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

(05 + 02 Marks)

(iii) Using a clearly labeled specific energy diagram, indicate flow profile positions from approach to the top of the bump.

(02 Marks)

Q 4.

(i) What is meant by the 'balance of forces' in uniform open channel flow? Can you use such a force balance to develop the Chezy/Manning's equation? Explain.

(04 Marks)

(ii) Fig. Q4 illustrates a flood stage of a natural channel that consists of a deep main channel and a floodplain. The main channel bed condition is clean and straight and the floodplain is shallow and rough with heavy brush.

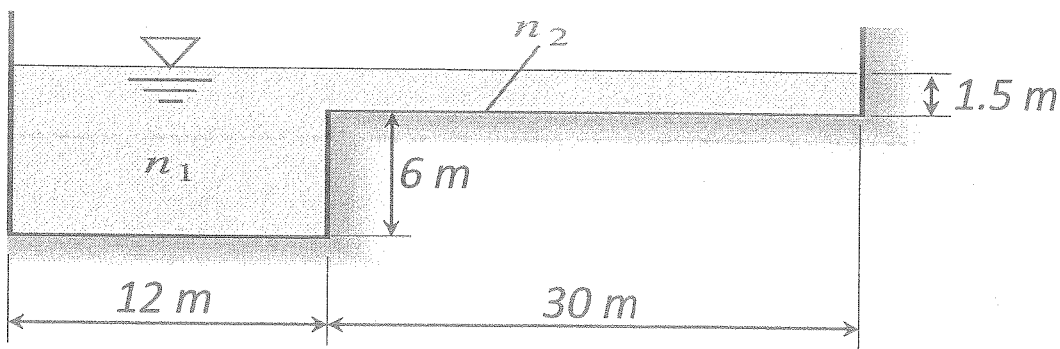

Figure Q4: Sectional view of an open channel and the flood plain.

(a) If the channel has the same slope everywhere, how would you analyze this situation for the discharge?

(b) Estimate the total discharge in m^3/s if the longitudinal slope of the channel is 0.0002.

(c) State all the assumptions made during the computations in above part (ii) (b).

(d) Under what conditions the assumptions in above part (ii) (c) are not appropriate?

(02 + 05 + 02 + 02 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	0.016
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