KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012
FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (WATER AND ENVIRONMENTAL ENGINEERING)

SET 320: HYDRAULICS I

DATE: Tuesday, 29th November, 2011 TIME: 11.00 a.m. – 1.00 p.m.

INSTRUCTIONS: Answer question **ONE** and any other **TWO** questions.

Question 1

a) Define the following terms used in connection with the flow of a liquid:
   i) Uniform flow
   ii) Steady flow
   iii) Unsteady flow
   iv) Mean velocity
   v) Discharge
   vi) Mass flow rate

(9 Marks)

b) A timber flume with $n = 0.013$ is in the form of an equilateral triangle (apex down) of 1.5 meters sides is laid on a slope of 1 in 100. Calculate the uniform flow rate which occurs at a depth of 120 cm.

(4 Marks)

c) i) Discuss what is meant by continuity of flow and state under what conditions it occurs.

(2 Marks)

ii) Oil flows through a pipeline which contracts from 500 mm diameter at A to 400 mm diameter at B and then forks, one branch being 200 mm in diameter discharging at C and the other branch 250 mm in diameter discharging at D. If the velocity at A is 1.8 m/s and the velocity at D is 3.6 m/s, calculate the discharges at C and D and the velocities at B and C.

(6 Marks)

d) i) State the forms of energy which a liquid in motion can posses and derive expressions for each of these forms in terms of pressure P, velocity V and elevation Z for a unit weight of fluid.

(6 Marks)

ii) Water at an altitude of 36 m above sea level has a velocity of 18 m/s and a pressure of 350 kN/m^2. Calculate the total energy per Newton of this water reckoned above sea level.

(3 Marks)

Question 2

a) i) State the Manning's formula for flow in channels.

(2 Marks)

ii) A canal has a bottom width B of 3.6 m and sides with a slope of 1 vertical to 2 horizontal. The slope of the bed is 1 in 4500 and the depth of water D is 1.3 m. Using the Manning's formula with n=0.025, determine the rate of discharge in m^3/s.

(6 Marks)

b) The cross section of an open channel consists of a semicircular bottom 1.2 m in diameter and with vertical sides. If the depth of water is 1.2 m and the bed slope is 1 in 2500, determine the value of C in the Chezy formula if the discharge is 0.402 m^3/s.

(4 Marks)

c) A smooth concrete lined channel has a trapezoidal cross section with base width 6 m and side slope 1V:2H. If the bed slope is 1 in 500, the quantity of flow is 40 m^3/s and n= 0.012, determine the normal depth for the channel.

(8 Marks)

Question Three

a) i) Derive the relationship between 'depth and breadth' and 'hydraulic radius and depth' for a rectangular channel of constant area A and bed slope S for maximum discharge.

(6 Marks)

ii) Determine dimensions for such a channel given that S=1/2500 and the discharge is 6.5 m^3/s. What will be the discharge if the depth is reduced by 6%? Take C=60

(6 Marks)

b) An open channel of 'economic' trapezoidal cross section with sides inclined at 60^0 to the horizontal is required to give a discharge of 10m^3/s when the slope of the bed is 1 in 1600. Determine the dimensions of the cross section, taking the constant n in Manning's formula as 0.014.

(8 Marks)

Question Four

a) Water flows across a broad crested weir in a rectangular channel 450 mm wide. The depth of the water just upstream of the weir is 75 mm and the crest of the weir is 42 mm above the channel bed. Calculate the fall of the surface level and the corresponding discharge assuming that the velocity of approach is negligible.

(4 Marks)

b) Water flows along a rectangular channel at a depth1.3 m when the discharge is 9.85 m^3/s. The channel width (B) is 5.3 m, the same as the weir (b). Ignoring energy losses, what is the minimum height (p) of a broad crested weir if it is to function with critical depth on the crest?

(6 Marks)

c) A 4 m wide channel carries a total discharge of 16 m^3/s. Calculate:

i) The critical depth
ii) The minimum specific energy
iii) The alternate depths at specific energy, E=5m

(10 Marks)

Question Five

a) Define the term 'hydraulic jump' and discuss under what conditions this may occur.

(3 Marks)

b) Analyze the water-surface profile before the change in slope in a long rectangular channel lined with concrete (n=0.013). The channel is 3 m wide; the flow rate is 50m^3/s, and the channel slope changes abruptly from 0.0150 to 0.0016. Determine whether or not a hydraulic jump will occur.

(7 Marks)

c) A hydraulic jump takes place in a 0.4 m wide laboratory channel. The upstream flow depth is 20 mm and the total flow rate is 31 litres per second. The channel is horizontal, rectangular and smooth. Determine the downstream flow properties and the energy dissipated in the jump. If the dissipated power could be transformed into electricity, how many 100 W bulbs could be lighted due to the jump?

(10 Marks)