NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
DEPARTMENT OF CIVIL AND WATER ENGINEERING
PART V SECOND SEMESTER EXAMINATIONS- MAY 2014

HYDRAULIC DESIGN II – TCW5201

Instructions:
Answer Any FOUR questions Total marks: 100

Time: 3 hours

QUESTION ONE

a. A venture flume with a throat width of 0.5m is constructed in a rectangular channel 1.5m wide. The depth of uniform flow in the channel at a discharge of 1.6 m^3/s is 0.92m; α=1.1. Assuming no energy losses verify that the flume acts as a critical depth flume and determine the upstream and throat depths. (15 marks)

b. Water flows along a rectangular channel at depth of 1.30m when discharge is 8.74m^3/sec and the channel width is 5.5m. Ignoring energy losses, what is the minimum height of a rectangular broad crested weir if it is to function with critical depth on its crest? (10 marks)

[25 marks]

QUESTION TWO

A culvert is to be built under a highway embankment where the design flood is 15 m^3/s, the width of the highway is 30m and the natural drainage slope is 0.015. Using corrugated pipes of diameter in multiples of 250mm with Manning's n =0.024; and an entry loss coefficient k_e=0.9:

a. Determine the size of the culvert barrel if the maximum permissible headwater level is 4m above the invert, with the barrel discharging free at its outlet. (15 marks)
b. If a fare edged entry (k_e=0.25) is chosen, calculate the required barrel diameter for the conditions in (a). (10 marks)

[25 marks]

QUESTION THREE

a. Describe the effects of sedimentation in reservoirs and suggest ways to counter these. (5marks)
b. Calculate the seepage per unit width using flow nets for an earth dam 30m high and with a 3m freeboard and a 3m crest width. The dam has a 1:2 upstream face slope and a 1:3 downstream

face slope. The dam material has a permeability coefficient of 0.0001cm/ sec. State any assumptions made clearly.

(20 marks)

[25 marks]

QUESTION FOUR

a. With aid of a neat sketch describe the middle third rule and explain its application in the design of concrete and masonry gravity dams. (5 marks)
b. A masonry gravity dam has an overall height of 35m, with a freeboard of 3m and a crest width of 4m. The dam has a 1:4 upstream face slope and a 1:2 downstream face slope. Assume that the uplift force takes a triangular distribution with maximum magnitude one third that of the hydrostatic pressure at the heel and at the toe. The specific gravity of the masonry is 2.65 and the coefficient of friction (μ) between the dam base and the foundation is 0.65. Check the dam for stability against overturning and sliding. State any assumptions made clearly.

(20 marks)

[25 marks]

QUESTION FIVE

a. Why is site investigation important in dam design? (5 marks)
b. Discuss flood routing as an essential tool in the design of dams. What other factors and considerations should be made in dam design? (10 marks)
c. A reservoir has a capacity of 5×10^6 m^3 and a drainage area of 190km^2. The average annual runoff from the water shed is 390mm, which brings in sediment quantity of 600m^3/km^2. Determine the time required to reduce the reservoir capacity to 1×10^6 m^3.

(10 marks)

[25 marks]

QUESTION SIX

a. Describe typical impacts on the environment by dam construction projects and suggest mitigation measures for these. (10 marks)
b. Describe the types of spillways and indicate where they are most suitable.

(5marks)

c. The coefficient of discharge for an overflow spillway is 1.89 at the head of 0.98 m. The length of the spillway is 9.5m. Determine the increase in discharge if the head increases to 1.25m while the discharge coefficient increases to 1.91. (10 marks)

[25 marks]

Useful Formulae

$$Q = \frac{2}{3}\sqrt{\frac{2g}{3}}\, b\, H_1^{3/2}$$

where b is the throat width and $H_1 = y_1 + \frac{\alpha V_1^2}{2g}$.