NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

HYDRAULIC DESIGN II

TCW 5201

Main Examination Paper

MAY 2015

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: NONE

Examiner's Name: Eng. A Chinyama

INSTRUCTIONS

1. Answer any Four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
6.	25
TOTAL	100

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QUESTION 1

What is the capacity of a 1.22m by 1.22m concrete box culvert (n=0.013) with a rounded entrance (k_e=0.05, C_d=0.95) if the culvert slope is 0.5%, the length is 36.6m and the headwater level is 1.83m above the culvert invert in the following cases?

a. Free-outlet conditions   (13marks)
b. Tail water elevation 0.304m above the top of the box at the outlet   (12 marks)

[25 marks]

QUESTION 2

a. 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)
b. Design a 60m long overflow spillway that will discharge a design flood of $1500m^3$/s at a maximum allowable pool elevation of 400m and the bottom elevation behind the spillway is 350m. The upstream face of the spillway is vertical and the spillway chute is to have a slope of 1:2 (H: V).
   (15 marks)

[25 marks]

QUESTION 3

a. Describe how flow measuring structures are calibrated.   (10 marks)
b. A 20cm high broad crested weir is placed in a 2m wide channel. Estimate the flowrate in the channel if the depth of water upstream of the weir is 50cm.   (15 marks)

[25 marks]

QUESTION 4

a. With aid of neatly labeled sketches describe the various types of embankment dams.   Highlight how the seepage is dealt with in each type.   (10 marks)

b. Calculate the seepage per unit width using flownets for an earth dam which is 30m high and has 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.   (15 marks)

[25 marks]

QUESTION 5

a. Describe typical impacts on the environment by dam construction projects and suggest mitigation measures for these.   (10 marks)
b. A reservoir is to be constructed with the following characteristics:

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QUESTION 5 Contd…

        Mean Annual Runoff, MAR =50mm

        Catchment Area = 286km^2

        Coefficient of Variation CV= 110%

        Full Supply Capacity FSC = 8x 10^{6}m^3

        What is the probability that the reservoir will fill to full capacity from empty in one year assuming that the runoff data follows the Weibull distribution function?

$$P(X\text{-}x) = 1\text{-}e^{-(aX/x)b}$$ (15 marks)

[25 marks]

QUESTION 6

For the concrete gravity dam shown below, Fig.Q6. All dimensions are in metres. Given that soil cohesion coefficient c = 1000kN/m^2, unit weight of concrete and water respectively γ_C = 24kN/m^3, γ_w = 9.81kN/m^3 and the coefficient of internal friction, tan φ=0.75.

a. Illustrate the pressure diagram showing all the forces affecting the stability of the dam. (8 marks)

b. Show whether the structure satisfies competence criteria with respect to

        i) Overturning (5 marks)

        ii) Sliding (5 marks)

   c. In case of a small value of the factor of safety for overturning how would you increase it without changing the structural dimensions of the given profile? (7 marks)

[25 marks]

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