# MACHAKOS UNIVERSITY

**University Examinations for 2022/2023**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF BUILDING AND CIVIL ENGINEERING**

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR**

**BACHELOR OF SCIENCE (CIVIL ENGINEERING)**

**ECV: 302 HYDRAULIC 1**

**DATE:** **TIME:**

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**INSTRUCTIONS**

**Answer Question One and Any Other Two Questions**

**QUESTION ONE (COMPULSORY) (30 MARKS)**

a) Define the terms alternate and critical depths. (2 marks)

b) List the classifications of flows in open channels (2 marks)

c) The specific energy for a 5m wide rectangular channel is to be 4m. if the rate of flow of water through the channel is 20m3/s, determine the alternate depths of flow. (3 marks)

d) Explain the main differences between pipe flow and open channel flow (5 marks)

e) A rectangular channel carries a discharge of 18 $m^3/s$ and the width of the channel is 6 m. Find the minimum specific energy of the flowing water. (4 marks)

f) Derive the equations governing the most economical sections of a trapezoidal channels. (5 marks)

g) A rectangular channel 2.50 m wide has a specific energy of 1.50 m when carrying a discharge of 6.48 m3/sec. Calculate the alternate depths and corresponding Froude numbers. Determine also the type of flow. (3 marks)

h) The discharge in a rectangular channel of width 6 m with Manning's $n$=0.012 is 24 $m^3/s$. If the bed slope is 1 in 200 find:

i. The normal depth (2 marks)

ii. The froude number at the normal depth (2 marks)

iii. The critical depth (2 marks)

State whether the normal flow is subcritical or supercritical.

**QUESTION TWO (20 MARKS)**

a) Define the term open channel flow. (2 marks)

b) Find the bed slope of trapezoidal channel of bed width 6 m, depth of water 3 m and side slope of 3 horizontal to 4 vertical, when the discharge through the channel is 30 m3/s. Take Chezy's constant, C = 70. (5 marks)

c) A rectangular channel 4m wide has a depth of water 1.5m. The slope of the bed of the channel is 1 in 1000 and the value of Chezy's constant C=55. It is desired to increase the discharge to a maximum by changing the dimensions of the section for constant area of cross-section, slope of the bed and roughness of the channel. Find the new dimensions of the channel and the increase in discharge. (7 marks)

d) The discharge of water through a rectangular channel of width 8m, is $15m^3/s$ when depth of flow is 1.2m. Calculate the following

i. Specific energy of the flowing water (2 marks)

ii. Critical depth and critical velocity (2 marks)

iii. Value of minimum specific energy (2 marks)

**QUESTION THREE (20 MARKS)**

a) Define the term specific energy. (2 marks)

b) With an aid of a well labeled diagram, draw a specific energy diagram (6 marks)

c) Derive the Chezy's formula for determination of discharge through an open channel (6 marks)

d) Drainage water flows in a rectangular channel having a manning's roughness coefficient n = 0.018. The channel slope is 1 in 7000. If the bottom width is 5m and depth of flow is 1.1m, calculate the following

a) Specific energy (4 marks)

b) Critical depth of flow (2 marks)

**QUESTION FOUR (20 MARKS)**

a) Define the term hydraulic jump (2 marks)

b) Discuss three industrial uses of hydraulic jumps in open flows (3 marks)

c) Water discharging into a 10-m-wide rectangular horizontal channel from a sluice gate is observed to have undergone a hydraulic jump. The flow depth and velocity before the jump are 0.8 m and 7 m/s, respectively. Determine

i. The flow depth and the Froude number after the jump, (3 marks)

ii. The head loss and the energy dissipation ratio, (3 marks)

e) A sluice gate discharge water into a horizontal rectangular channel with a velocity of 6 m/s and depth of flow is 0.4m. the width of the channel is 8m. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water. /Also determine the power lost in the hydraulic jump (5 marks)

f) The depth of flow of water at a certain section of a rectangular channel of 2m wide is 0.3m. the discharge through the channel is 1.5m3/s. determine whether a hydraulic jump will occur and if so find its height and loss of energy. (4 marks)

**QUESTION FIVE (20 MARKS)**

a) A trapezoidal channel has sides slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 1500. The area of the section is $40m^2$. Find the dimensions of the section if it is most economical. Determine also the discharge of the most economical section if C=50. (6 marks)

b) Derive the equation for minimum specific energy in terms of critical depth. (3 marks)

c) A trapezoidal channel has side slopes of 3 horizontal to 4 vertical and slope of its bed is 1 in 2000. Determine the optimum dimensions of the channel, if it is to carry water at 0.5 $m^3/s$. Take chezy's constant 80. (5 marks)

d) A rectangular channel with a bottom width of 4.0 m and a bottom slope of 0.0008 has a discharge of 1.50 m3/sec. In a gradually varied flow in this channel, the depth at a certain location is found to be 0.30 m. assuming n = 0.016, determine the following,

i) The normal depth ($y_o$) (2 marks)

ii) Critical depth ($y_c$). (2 marks)

iii) Type of GVF profile. (2 marks)