



MACHAKOS UNIVERSITY

University examinations 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR IN CIVIL ENGINEERING

ECV 302: HYDRAULICS I

Date 6/3/2023

Time: 2:00 – 4:00 PM

INSTRUCTIONS

- *This paper comprises of four questions. Answer **two** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **one** questions*

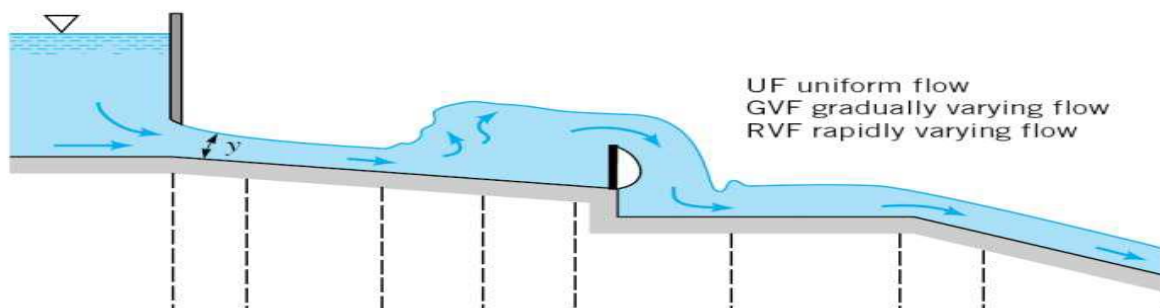
QUESTION ONE

- a) Define the term open channel flow. (2 marks)
- i. Differentiate the following terms.
- ii. Critical depth and critical velocity. (2 marks)
- b) Hydraulic radius and hydraulic depth. (2 marks)
- c) Explain the main differences between pipe flow and open channel flow (4 marks)
- d) Prove with illustrations that for a most economical section of a rectangular channel, either the depth of the flow is half the width or the hydraulic radius is half the depth of flow. (5 marks)

- e) A Rectangular Channel of width, 4 m is having a bed slope of 1 in 5000. Find the maximum discharge through the channel. Take value of Chezy's constant $C = 50$. (4marks)
- f) A rectangular channel with a semicircular bottom of 2m diameter is used to discharge effluent from Machakos University main administration block. Calculate the discharge through the channel when the depth of flow is 2m. Take Chezy's constant $C = 70$ and the bed slope is 1 in 1000. (5 marks)
- g) 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, $C = 70$. (4marks)
- h) By use of the Manning's equation, estimate the flow rate of a rectangular brick channel with the following characteristics $n = 0.016$, width is 2 m and a bed slope of 0.0012. (2 marks)

QUESTION TWO

- a) Define the term best hydraulic section (2 marks)
- b) The diagram below shows a cross-section of a flow channel. Indicate in **each section** whether the flow is Uniform Flow (UF), Gradually Varying Flow (GVF) or Rapidly Varying Flow (RVF) (3 marks)



- c) A concrete lined trapezoidal channel with uniform flow has a normal depth of 2m. The base width is 5m and the sides slopes are in the ratio of 1:2. Manning's n can be taken as 0.015 and $s_o = 0.001$. calculate
- Discharge
 - Mean velocity
 - Reynolds number if $\mu = 1.14 \times 10^{-3} \text{ NS/m}^2$ (7 marks)

- d) Derive the Chezy's formula for determination of discharge through an open channel (5 marks)
- e) Calculate the discharge of effluent through a triangular channel having a flow depth of 3m and side slopes of 1H:2V, the bed slope is 1 in 500 and the Chezy's constant $C = 60$. (3 marks)

QUESTION THREE

- a) Define the term specific energy (2 marks)
- b) Differentiate the term alternate depth and sequent depths (4 marks)
- c) With an aid of a well labeled diagram, draw a specific energy diagram (6 marks)

Water in Kathonzwi irrigation scheme in Makueni County flows in a rectangular channel having a Manning's roughness coefficient $n = 0.017$. 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 (4 marks)

QUESTION FOUR

- a) Define the term hydraulic jump (2 Marks)
- b) State the conditions necessary for the formation of a hydraulic jump (3 marks)
- c) Water discharging into a 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
- a) The flow depth and the Froude number after the jump, (4 marks)
- b) The head loss and the energy dissipation ratio, (4 marks)
- d) A rectangular horizontal channel 2m wide, carries a flow of 4 m³/s. The depth water on the downstream side of the hydraulic jump is 1m.
- a) What is the depth upstream? (3 marks)
- b) What is the head loss? (3 marks)

QUESTION FIVE

- a) Describe four types of weirs that are used for flow measurements (4marks)
- b) For a constant specific energy of 1.8, calculate the maximum discharge that may occur in a rectangular channel 5m wide. (4 marks)
- c) The velocity of water flowing uniformly in a rectangular flume of base width of 600mm is $0.1\text{m}^3/\text{s}$. The depth of flow is 300mm and Chezy's constant is 56. Calculate the following.
 - a) Bottom slope of the flume (3 Marks)
 - b) Conveyance 'K' of the flume (2 marks)
- d) A rectangular channel with a bottom width of 4.0 m and a bottom slope of 0.0008 has a discharge of $1.50\text{ m}^3/\text{sec}$. 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,
 - a) The normal depth (y_o) (3 marks)
 - b) Critical depth (y_c). (2 marks)
 - c) Type of GVF profile. (2 marks)