GUJARAT TECHNOLOGICAL UNIVERSITY

BE-6 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:

OPEN CHANNEL FLOW (3160618)

Unit 1: Basic Flow Concepts

Repeated Questions:

1. Differentiate between pipe flow and open channel flow. (S23 - Q1a, 03 marks) (S24 - Q1a, 03 marks) (S25 - Q1a, 03 marks)
2. Explain/Discuss/Write short note on velocity distribution in open channel flow. (S22 - Q1b, 04 marks) (S23 - Q1b, 04 marks) (S25 - Q1b, 04 marks)
3. What are the different types of channels? (S22 - Q1a, 03 marks) (S25 - Q1b, 03 marks)

Other Important Questions:

1. Classify the flows in channel. (W23 - Q1a, 03 marks)
2. Draw definition sketch of energy equation. (W23 - Q1c, 07 marks)
3. Show that for a very wide rectangular channel the hydraulic radius is equal to the depth of flow in the channel. (W24 - Q1a, 03 marks)
4. Explain the continuity and momentum equation for open channel flow. (S22 - Q1c, 07 marks)
5. Draw a definition sketch to derive the equilibrium equation: $\tau = wRS_0$ for uniform steady flow. (W24 - Q1b, 03 marks)
6. Draw a definition sketch to show hydraulic grade line and energy line to show the difference between pipe flow and open channel flow. (W24 - Q2a, 03 marks)
7. Explain with neat sketch velocity distribution and pressure distribution in open channels. (S23 - Q4a, 03 marks) (S24 - Q2a, 03 marks) [Diagram given - refer Question paper of S23/S24]
8. Explain with example the velocity distribution in open channel. (W22 - Q1b, 04 marks)
9. Derive the basic equation of continuity for steady and unsteady open channel flow. (W22 - Q2b, 04 marks)

Unit 2: Energy and Momentum Principles

Repeated Questions:

1. What is specific energy? Draw curve of it. / Draw the definition sketch of specific energy and explain it. (S22 - Q2a, 03 marks) (S25 - Q3b, 04 marks) (S24 OR - Q3c, 07 marks) [Diagram given - refer Question paper of S22/S25]
2. Derive the expressions for the critical depth in channels of various/circular and trapezoidal sections. (W22 - Q1c, 07 marks) (S25 - Q1c, 07 marks) (W23 - Q1b, 04 marks)
3. Explain the concept of first hydraulic exponent in detail. / Explain the first hydraulic exponent (M) for the rectangular channel. (S25 - Q1c, 07 marks) (S23 - Q4a, 03 marks)
4. Define/Explain: Critical depth, Alternate depths, Sequent/Conjugate depths, Section factor, Froude Number. (S22 - Q2b, 03 marks) (S24 - Q2b, 04 marks) (W23 - Q3a, 03 marks) (S25 - Q2a, 03 marks)

Other Important Questions:

1. Obtain the value of first hydraulic exponent (M) for the rectangular and triangular channels. (W23 - Q2b, 04 marks) (S25 - Q2b, 04 marks)
2. Define normal depth, critical depth, alternate depth and conjugate depths. (S24 - Q2b, 04 marks)
3. Derive an expression showing a relation between alternate depths and Froude number for a hydraulic jump in a horizontal rectangular channel. (S23 - Q2b, 04 marks)
4. Show that the critical depth y_c is related to alternate depths y_1 and y_2 in a rectangular channel by the equation, $y_c = \left(\frac{2y_1^2y_2^2}{y_1+y_2}\right)^{1/3}$. (S23 - Q2c, 07 marks)
5. Explain channel transition with a hump. (S25 - Q2b, 04 marks)
6. Show that for a rectangular channel the critical depth $y_c = \left(\frac{q^2}{g}\right)^{0.333}$. (W24 - Q2b, 03 marks)
7. Define critical flow. Derive an expression for minimum energy in terms of critical depth. (S24 OR - Q3b, 04 marks)
8. A 5.5m wide channel conveys water at a depth of 2.0m. The bed slope of the channel is 0.001. Find the width to be provided in the transition so as to obtain critical depth. Alternately with the same width of 5.5m, find the rise in bed level required to produce critical flow in the channel. Take Manning's coefficient N = 0.018. (S23 OR - Q2c, 07 marks) (S24 OR - Q3c, 07 marks)
9. Calculate the critical depth and the corresponding specific energy for a discharge of $5\text{m}^3/\text{s}$ in the rectangular channel of width 2.0m. (S22 OR - Q3a, 03 marks)
10. For a constant specific energy 2.4 joules per newton calculate the maximum discharge that may occur in a rectangular channel 4 meter wide. (W24 OR - Q2c, 07 marks)
11. Find the critical depth for a specific energy head of 1.5m in the following channels: (a) Rectangular channel, B = 2.0m (b) Triangular channel, B = 1.5m (c) Trapezoidal channel, B = 2.0m and m = 1.0m. (W23 OR - Q2c, 07 marks)
12. Show that in triangular channel the froude number corresponding to alternate depth are given by $\text{F1/F2} = (4 + \text{F}_2^2)^{5/2}/(4 + \text{F}_2^2)^{5/2}$. (W23 - Q2c, 07 marks)
13. Use specific energy diagram to explain the variation of upstream and downstream depth of flow for a rectangular channel due to provision of hump (i) when approaching depth is sub critical (ii) when approaching depth is supercritical. (W24 OR - Q5c, 07 marks) [Diagram given - refer Question paper of W24]

Unit 3: Uniform Flow in Rigid Boundary Channels

Repeated Questions:

1. Derive Chezy's equation $V = C\sqrt{RS}$ with usual notations. (S23 - Q5a, 03 marks) (S24 OR - Q3a, 03 marks)
2. Explain various factors affecting Manning's roughness coefficient. (S23 - Q2a, 03 marks) (S24 OR - Q3a, 03 marks)
3. Write a note on Manning's roughness coefficient. / Write a note on Mannings roughness coefficient. (W22 - Q3a, 03 marks) (S25 - Q4b, 04 marks)
4. Derive conditions for most economic (i) Rectangular Section (ii) Trapezoidal Section. (S23 OR - Q3c, 07 marks) (S24 OR - Q4c, 07 marks)

Other Important Questions:

1. Describe the hydraulically-efficient channel section. Also explain the relationship between the geometric elements to form an efficient section. (S25 - Q2c, 07 marks)
2. Discuss the types of uniform flow computation problems. (W22 - Q3b, 04 marks)
3. Explain the second hydraulic exponent (N). (S25 - Q3a, 03 marks)
4. Explain the term section factor for a uniform flow. (W24 OR - Q4b, 04 marks)
5. Obtain the value of second hydraulic exponent (N) for the rectangular and triangular channels. (S25 - Q3b, 04 marks) *[Note: Syllabus lists "second hydraulic exponent", question in paper asks for "first hydraulic exponent (M)". Placed here as per syllabus unit.]*
6. Derive the equations of hydraulic mean depth for triangular and trapezoidal channel sections of rigid boundary channels. (W22 OR - Q3b, 04 marks)
7. Explain the concept of equivalent roughness of a channel. (W22 OR - Q3c, 07 marks)
8. Derive the expression for estimating equivalent roughness of a channel. (S25 OR - Q3b, 04 marks)
9. Explain equivalent roughness in channel. (S25 - Q2a, 03 marks)
10. A trapezoidal channel of 12m bottom width, side slope 1.5H:1V, has a bed slope of 0.0003. The value of n is 0.012, If the depth of flow is 4m, compute average velocity, discharge, and bed shear. (S23 - Q1c, 07 marks)
11. A trapezoidal channel is 10m wide and has a side slope of 1.5(H) : 1(V). The bed slope is 0.0003. The channel is lined with smooth concrete of n = 0.012. Compute the mean velocity and discharge for a depth of flow of 3.0m. Also find the bottom slope necessary to carry only 50m³/s of the discharge at a depth of 3.0m. (S25 - Q2c, 07 marks)
12. In a wide rectangular channel other factors remaining constant if the normal depth is increased by 20% find the increase in discharge using Chezy's equation. (W24 OR - Q4c, 07 marks)
13. Use Chezy's equation to explain conveyance of flow in a uniform steady open channel flow. (W24 - Q5a, 03 marks)
14. Use Manning's equation to explain the terms normal flow and normal discharge for a uniform flow. (W24 OR - Q3b, 03 marks)
15. A sewer pipe is proposed to be laid on a slope of 1 in 3000 and is required to carry a discharge of 2 cumec. What size of the pipe should be used if you plan it to flow half full? Take Manning's n = 0.014. (W24 - Q5c, 07 marks)
16. Explain velocity distribution for turbulent flow in channel. (W23 OR - Q3c, 07 marks)

Unit 4: Uniform Flow in Mobile Boundary Channels

Repeated Questions:

1. Explain/Discuss/Write note on incipient motion condition / Shield's analysis. (S22 - Q5a, 03 marks) (W22 - Q2c, 07 marks) (S25 OR - Q3c, 07 marks) (W23 OR - Q4b, 04 marks) (S25 OR - Q4c, 07 marks)
2. Explain/Discuss regimes of flow & prediction of regimes. (S22 - Q4c, 07 marks) (W22 - Q3a, 03 marks) (S24 - Q2c, 07 marks)

Other Important Questions:

1. Differentiate between Kennedy's theory and Lacey's regime theory. (S23 - Q3a, 03 marks) (S24 - Q1b, 04 marks)
2. Explain in brief Lacey's regime theory. (S22 - Q5a, 03 marks) (W23 OR - Q4a, 03 marks)
3. What are the limitations of Kennedy's theory? (W23 - Q5a, 03 marks)
4. Define the terms: regime flow, ripples, dunes. (S25 OR - Q3a, 03 marks)
5. What do you mean by non-scouring channels? (S22 OR - Q4b, 04 marks)
6. Discuss the permissible velocities in rigid boundary channels. (W22 - Q4b, 04 marks) (S23 - Q5b, 04 marks)
7. Explain concept of shield's analysis for uniform flow in mobile Boundary channels. (W23 OR - Q4b, 04 marks) (S25 OR - Q4c, 07 marks)
8. Describe the Shields curve and discuss its salient features. (W24 OR - Q3c, 07 marks) [Diagram given - refer Question paper of W24]
9. Explain grain shear stress and form shear stress for a mobile boundary channel. (W24 OR - Q4a, 03 marks)
10. If the grain size of a bed material of an alluvial channel is 1mm, specific gravity is 2.65, bed slope of channel is 0.0001, find the depth in wide rectangular channel when sediment just begin to move. (S24 OR - Q5b, 04 marks)
11. What are the types of bed forms? What is the difference between aggradation and degradation? (S22 - Q5b, 04 marks)

Unit 5: Design of Channels

Repeated Questions:

1. Explain/Write note on design of lined canal / procedure of designing lined canal. (S25 - Q4c, 07 marks) (W22 OR - Q4c, 07 marks)
2. Design a channel (lined/unlined) for a given discharge. (W22 OR - Q4c, 07 marks) (S25 OR - Q5c, 07 marks) (S25 OR - Q4c, 07 marks)

Other Important Questions:

1. Discuss the requirements for the selection of type of canal lining. (S25 OR - Q3a, 03 marks)
2. Explain the Shear stress distribution for uniform flow in lined canals. (S25 OR - Q3b, 04 marks)
3. Explain the stepwise procedure to design the channel using tractive force method. (S25 OR - Q3c, 07 marks)
4. Draw the typical section of a lined irrigation canal. (S25 - Q4a, 03 marks) [Diagram given - refer Question paper of S25]
5. A concrete lined trapezoidal channel (n=0.015) is to have a side slope of 1:1. The bottom slope is 0.0004. Find the bottom width of the channel necessary to carry 100m^3/s of discharge at normal depth of 2.5m. (S22 OR - Q4a, 07 marks)
6. An irrigation canal has a side slope of 1:1 and bottom width of 3.50m. It runs at a depth of 1.20m with a bed slope of 1 in 2500. Determine whether the canal will be silting or scouring or remain stable. Take Manning's coefficient N = 0.028. Use a value of m = 1 in Kennedy's theory. (S23 - Q4b, 07 marks) (S24 OR - Q4c, 07 marks)
7. A trapezoidal channel is to carry a discharge of 50 m^3/s. The maximum slope that can be used is 0.004. The soil is hard. Design the channel as (a) a lined canal with concrete lining and (b) an unlined non-erodible channel. Take, For lined canal m = 1.0, n for concrete = 0.013, For B/y0 = 8.0, ω = 0.03108 For unlined canal, m = 1.0, n for hard soil surface = 0.020, For B/y0 = 8.0, ω = 0.03108. (S25 OR - Q4c, 07 marks)
8. Write the steps to design lined channel using different empirical equations. (S25 OR - Q4c, 07 marks)
9. A standard lined trapezoidal canal section is to be designed to convey 100 m^3/s of flow. The side slopes are to be 1.5 horizontal: 1 vertical and Manning's n = 0.016. The longitudinal slope of the bed is 1 in 5000. If a bed width of 10.0 m is preferred what would be the normal depth? (W23 OR - Q5c, 07 marks)

Unit 6: Gradually Varied Flow

Repeated Questions:

1. Derive differential equation of gradually varied flow with assumptions. (S22 - Q2c, 07 marks) (S24 OR - Q5c, 07 marks)
2. Define gradually varied flow and rapidly varied flow. / Differentiate between Gradually varied flow and Rapidly varied flow. (S22 - Q4a, 03 marks) (S24 OR - Q5a, 03 marks) (S25 - Q1a, 03 marks)
3. Explain classification of flow profiles / Give the classification of flow profiles. (S22 - Q3c, 07 marks) (S25 - Q4b, 04 marks)
4. Explain/Draw M1, M2, and M3 / S1, S2, and S3 type surface profiles with examples. (S23 OR - Q5c, 07 marks) (S24 OR - Q5c, 07 marks)

Other Important Questions:

1. What is gradually varied flow? What are the basic assumptions involved in analysis of GVF? (W22 OR - Q4a, 03 marks)
2. State the assumptions made in the derivation of dynamic equation of gradually varied flow profile. (W24 OR - Q3b, 03 marks)
3. Draw the schematic sketch of Gradually varied flow. (S25 - Q5a, 03 marks) [Diagram given - refer Question paper of S25]
4. Write on drawdown and back water curves. / Differentiate between the back water curve and drop-down curve. (S22 - Q3a, 03 marks) (S23 OR - Q3a, 03 marks) (S24 OR - Q5b, 04 marks)
5. Explain the features of type M and type S profiles. (W22 OR - Q4b, 04 marks)
6. Explain in detail 'S' type flow profile. (W23 OR - Q3a, 03 marks)
7. Write short note on 'Transitional Depth'. (W23 OR - Q3b, 04 marks)
8. What data or information are generally needed for computing a flow profile? (S25 - Q4a, 03 marks)
9. State the rule regarding the direction of computation of flow profiles. (S25 OR - Q4a, 03 marks)
10. Explain why H1 and A1 profiles are practically not possible. (S25 OR - Q4b, 04 marks)
11. Describe different types of bottom slopes of open channels. (S25 OR - Q4c, 07 marks)
12. Distinguish between direct step method and standard step methods for computation of flow profiles. (S25 OR - Q4a, 03 marks)
13. Describe the flow profiles in divided channels. (S25 OR - Q4b, 03 marks)
14. Which are the different simple numerical solutions of GVF problem. (W23 - Q4a, 03 marks)
15. For an open channel steady gradually varied flow draw a control volume show the forces acting on this control volume to apply the momentum equation across the two sections. (W24 OR - Q3a, 03 marks) [Diagram given - refer Question paper of W24]
16. Cite the practical situations in which M1 and M2 type of profiles occur and explain their characteristics using the dynamic equation of the gradually varied flow. (W24 OR - Q3c, 07 marks)
17. In a rectangular channel 3.5m wide laid at a slope of 0.0036, uniform flow occurs at a depth of 2.0m. Find how high the hump be raised without causing afflux? (S22 - Q4c, 07 marks)

Unit 7: Hydraulic Jump

Repeated Questions:

1. What is hydraulic jump? Explain applications / uses of it. (S22 - Q3b, 04 marks) (S23 - Q5c, 07 marks) (S24 - Q1c, 07 marks)
2. Describe the classifications of hydraulic jump. / Explain: Undular jump, weak jump, oscillating jump, steady jump. (W23 - Q4b, 04 marks) (W22 - Q5b, 04 marks) (S23 OR - Q5b, 04 marks)
3. Write a note on location of hydraulic jump. (W22 - Q5a, 03 marks) (S22 OR - Q3b, 04 marks)

Other Important Questions:

1. Discuss the characteristics of jump in a rectangular channel. (W22 - Q4a, 03 marks) (S25 - Q5b, 03 marks)
2. Classify the hydraulic jumps in horizontal rectangular channels according to USBR. (S25 OR - Q5c, 07 marks)
3. Write the practical applications of hydraulic jumps. (S25 - Q5a, 03 marks)
4. Discuss the practical utility and application of hydraulic jump. (W24 - Q1c, 03 marks)
5. A hydraulic jump takes place in a rectangular channel with sequent depths of 0.25m and 1.5m at the beginning and end of the jump respectively. Estimate the i) discharge per unit width of the channel and ii) energy loss. (S22 - Q5b, 07 marks)
6. A spillway discharges a flood flow at a rate of 7.75 m^3/s per metre width. At the downstream horizontal apron, the depth of flow was found to be 0.50m. What tailwater depth is needed to form a hydraulic jump? If a jump is formed, find its (a) type, (b) length, (c) head loss, (d) energy loss as a percentage of the initial energy. (S25 OR - Q3c, 07 marks)

Unit 8: Rapidly Varied Flow

Repeated Questions:

1. Explain (1) sluice gate / Write a detailed note on sluice gates. (W22 OR - Q5b, 04 marks) (S25 OR - Q5c, 07 marks)
2. Explain/Discuss in detail (i) Standing Wave Flume & (ii) Parshall Flume. (S23 - Q4c, 07 marks) (W23 - Q4c, 07 marks) (S25 - Q5c, 07 marks)

Other Important Questions:

1. Discuss various characteristics of Rapidly Varied Flow. (S23 OR - Q5a, 03 marks)
2. Define Rapidly varied flow. Also give the characteristics of rapidly varied flow. (S25 OR - Q5a, 03 marks)
3. Differentiate between Sharp crested weir and broad crested weir. (S25 - Q5b, 04 marks)
4. Derive expression for the discharge over circular and trapezoidal sharp-crested weir. (W22 OR - Q5c, 07 marks)
5. Compute the discharge over an ogee weir / Calculate the discharge over the weir by considering the velocity of the approach. (S23 - Q4b, 07 marks) (S24 OR - Q3c, 07 marks)
6. Describe the characteristics of Sluice-Gate flow. (S25 OR - Q5b, 04 marks)
7. Describe the characteristics of flow over spillway. (W23 OR - Q5b, 04 marks)
8. A square conduit of side s, placed with its diagonal vertical acts as an open channel. Show that the channel carries maximum discharge when y = 0.95D. (S25 - Q3b, 03 marks)

Unit 9: Unsteady Flow

Repeated Questions:

1. Explain surges in open channel and their types. / Explain positive and negative surges in open channel. (S22 OR - Q2c, 07 marks) (S25 OR - Q5b, 04 marks) (W23 - Q5b, 04 marks) (S25 OR - Q5a, 03 marks)
2. Derive the equation of motion for Gradually Varied Unsteady Flow (GVUF) in a prismatic channel. (W23 - Q5c, 07 marks) (S25 OR - Q5c, 07 marks)

Other Important Questions:

1. What is unsteady flow? What are the types? (S22 - Q4b, 04 marks)
2. Define wave. Explain different types of waves. (S24 - Q4a, 03 marks)
3. Explain Froude number as a ratio of flow velocity to celerity so give reasons why ripples do not travel upstream in a supercritical flow. (W24 - Q3a, 03 marks)
4. Explain positive and negative surge moving downstream. (S24 OR - Q5a, 03 marks)
5. Give the reasons why positive surges have a stable profile and preserved shape while negative surge have an unstable profile. (W24 OR - Q5a, 03 marks)
6. Draw the definition sketch giving causes of occurrence for (i) positive surge moving upstream and a positive surge moving downstream (ii) negative surge moving upstream and negative surge moving downstream. (W24 OR - Q5b, 04 marks) [Diagram given - refer Question paper of W24]
7. Enlist various numerical methods for solving St. Venant equation. (W22 OR - Q5a, 03 marks)
8. Explain and derive St. Venant's equation. (S22 OR - Q3c, 07 marks)
9. In the measurement of discharge in the river, it was found that the depth increases at a rate of 0.75m per hour. If the discharge in a river at that section is $20m^3/sec$ and the surface width of the river is 20m. estimate the discharges at a section 1.4 km upstream. (S23 - Q1b, 04 marks)

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