

Date : October 11, 2025
Total Marks : 100
Writing Time : 150 minutes (2.5 hours)
Reading Time : 15 minutes (prior to writing time)

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts:

Part I - 30 Multiple Choice Questions

Part II - 4 Short Answer Questions

All questions under SECTION A are COMPULSORY.
 - **SECTION B** consists of **SIX QUESTIONS**. Choose only **FIVE** questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part on a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **9 printed pages**, including this instruction page.

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SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. The field of hydrology deals with:
 - a) surface and ground water
 - b) flood water
 - c) river water
 - d) rainwater

2. What percentage of the world's water is potable?
 - a) less than 3%
 - b) about 15%
 - c) about 25%
 - d) more than half

3. Runoff is measured in:
 - a) cubic meters
 - b) cubic meters per sec
 - c) cubic meters per minute
 - d) cubic meters per hour

4. The runoff is affected by:
 - a) rain intensity and duration
 - b) rain distribution
 - c) soil moisture
 - d) all of the above

5. Pick up the correct equation from the following:
 - a) $\text{Run off} = \text{Surface run off} + \text{Ground water flow}$
 - b) $\text{Run off} = \text{Surface run off} - \text{Ground water flow}$
 - c) $\text{Run off} = \text{Surface run off} / \text{Ground water flow}$
 - d) $\text{Run off} = \text{Surface run off} \times \text{Ground water flow}$

6. In Bhutan, rainfall is recorded by:
 - a) National Biodiversity Center
 - b) National Center for Hydrology and Meteorology
 - c) Department of Water
 - d) Ministry of Infrastructure and Transport

7. A hyetograph is a graphical representation of:
 - a) discharge and time
 - b) cumulative rainfall and time
 - c) rainfall intensity and time
 - d) rainfall depth and time
8. A hydrograph is a graphical representation of:
 - a) rain fall
 - b) discharge flowing in the river
 - c) surface runoff
 - d) all of the above
9. For determination of average annual precipitation in a catchment basin, the best method is:
 - a) Thiessen's mean method
 - b) Arithmetical method
 - c) Isohyetal method
 - d) none of the above
10. The average mean velocity of a stream having depth h may be obtained by taking the readings of a current meter at a depth of:
 - a) $0.1 h$ and $0.9 h$
 - b) $0.2 h$ and $0.8 h$
 - c) $0.3 h$ and $0.7 h$
 - d) $0.4 h$ and $0.6 h$
11. The time required by rainwater to reach the outlet of the drainage basin is generally called:
 - a) time of concentration
 - b) duration of rainfall
 - c) time of overland flow
 - d) detention time
12. The following is **NOT** a geological factor governing the occurrence of groundwater.
 - a) porosity of the soil
 - b) permeability of the soil
 - c) transmissibility of the soil
 - d) elasticity of the soil
13. The quantity of water available from an infiltration gallery depends upon the:
 - a) the yield of the aquifer source
 - b) size of gallery
 - c) the efficiency of the drain pipes
 - d) all of the above

14. If the grain size of soil increases,
- a) water supply in well increases
 - b) specific retention decreases
 - c) surface area decreases
 - d) all of the above
15. Sharp crested weirs are generally used for:
- a) small flows
 - b) large flows
 - c) streams carrying high sediment loads
 - d) rivers carrying floating debris
16. Per capita demand of water is calculated in liters:
- a) per person per year
 - b) per person per month
 - c) per person per day
 - d) none of the above
17. Per capita water demand is defined as the liters of water consumed daily by each person over a period of:
- a) 24 hours
 - b) one month
 - c) one year
 - d) 10 years
18. Generally, the multiplying (peak) factor that is applied to compute the maximum daily water demand in relation to the average per capita daily demand is:
- a) 1.5
 - b) 1.8
 - c) 2.0
 - d) 2.7
19. In Water Supply Engineering “meters water column” is frequently used as a unit of pressure (head) expressed as “mwc” or “cm-wc”.
10 m water column (mwc) is equivalent to:
- a) 0.1 bar
 - b) 1 bar
 - c) 10 bar
 - d) 100 bar

20. The distribution system in a typical urban water supply is designed on the basis of::
- a) average daily demand
 - b) peak hourly demand
 - c) maximum daily demand + fire demand
 - d) greater of (b) and (c)
21. In a hydraulic system, there are Elevation Head, Pressure Head, and Velocity Head.
The Total Energy Head in a hydraulic system is equal to:
- a) Elevation Head - Pressure Head + Velocity Head
 - b) Elevation Head - Pressure Head - Velocity Head
 - c) Elevation Head + Pressure Head - Velocity Head
 - d) Elevation Head + Pressure Head + Velocity Head
22. The formula which is most appropriate to the design of pressure pipes is:
- a) Mannings formula
 - b) Darcy Weisbach formula
 - c) Dupuit's formula
 - d) Chezy's formula
23. The Hydraulic Grade Line (HGL) is a graph of the pressure head _____ the pipe centerline.
- a) along
 - b) below
 - c) above
 - d) near
24. The energy loss due to viscosity and friction along the straight length of the pipeline is called _____ loss and accounts for most of the pressure drop.
- a) major loss
 - b) minor loss
 - c) apparent loss
 - d) physical loss
25. As the water flows through valves, bends, and other tube fittings, there are additional losses due to turbulence which is called _____ losses.
- a) major loss
 - b) minor loss
 - c) apparent loss
 - d) physical loss

26. Pressure pipes are exclusively used for carrying water supplies because:
- a) such pipes can go up and down the hills and valleys thus requiring a lesser length
 - b) such pipes are closed and hence not exposed to pollution
 - c) since water runs under pressure, pollution from the outside surrounding cannot enter even if some joints are loose
 - d) all of the above
27. Water hammer pressures can be reduced by using:
- a) critically closing time valves
 - b) fast closing valves
 - c) slow closing valves
 - d) none of the above
28. Air valves are special kinds of valves that are generally placed at the _____ along the pipeline.
- a) summit
 - b) bottom
 - c) middle
 - d) none of the above
29. Check valves are installed:
- a) on the delivery side of the pump
 - b) at the interface connection between the treated water and raw water
 - c) both (a) and (b)
 - d) neither (a) nor (b)
30. Which of the following system/type is used in a water distribution network?
- a) dead end system
 - b) radial system
 - c) grid iron system
 - d) all of the above

PART II – Short Answer Questions [20 marks]

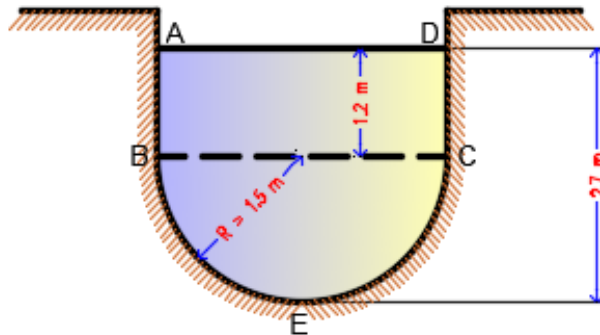
This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

1. How is the design flood for a structure determined?
2. What is Manning's equation and where is it used? Calculate flow rate in a rectangular channel.
Given: width = 4 m, depth = 2 m, slope = 0.001, Manning's $n = 0.015$.
3. Compute the peak discharge using the Rational Method.
Given: $C = 0.7$, rainfall intensity $i = 60$ mm/hr, catchment area $A = 5$ km².
4. Water is flowing at a velocity of 2 m/s in a 200 mm diameter pipe. The pipe diameter is reduced to 100 mm at a constriction in the pipe. Determine the flow velocity in the constricted pipe section. Discuss the result.

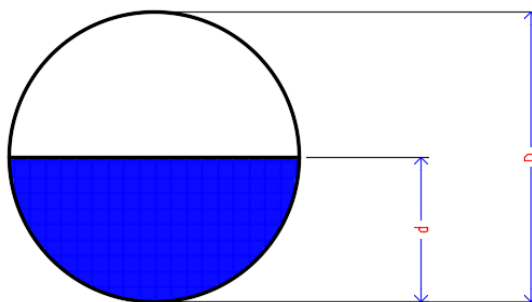
SECTION B: Case Study [50 marks]

There are 6 Questions in this Section. Choose 5 Questions out of the 6 Questions. Each Question carries 10 marks. Refer to the list of formulas given at the end of the Section.

1. Explain with neat sketches various types of aquifers.
2. The leakage in a water distribution system was $20 \text{ m}^3/\text{h}$ at the average pressure of 50 m. Given $L = K P^{1.5}$, where L = Leakage, P = Pressure
 - a) What will be the leakage at the average pressure of 40 m?
 - b) What should be the average pressure in the above distribution system to reduce the leakage to $10 \text{ m}^3/\text{h}$?
 - c) List the causes of high water losses in a distribution system.
3. (a) What should be the production capacity in m^3/h of a treatment facility that has to supply a city with 300,000 people with an average quantity of 130 Lpcd?
 (b) If the population of the city is increasing geometrically at the rate of 2% per year, estimate the increase in the production capacity of the treatment plant required after 15 years for the following cases:
 - (i) The average total per capita water demand remains constant (130 Lpcd)
 - (ii) The average total per capita water demand increases linearly 1% per year
4. Determine the discharge of water through the channel shown in figure below. Take the value of Chezy's constant as 60 and slope of the bed as 1 in 2000.



5. Find the diameter of a circular sewer pipe which is laid at a slope of 1 in 8000 and carries a discharge of 800 l/s when flowing half full. Take the value of Manning's N as 0.02 (Refer figure below).



6. A town with a population of 100,000 has a total per capita water demand of 100 Lpcd (liters per capita per day).
Calculate (i) annual average daily demand (m^3/day), (ii) maximum daily demand (m^3/day), (iii) average hourly demand (m^3/hour), (iv) maximum hourly demand (m^3/hour), (v) maximum hourly demand of the maximum day (m^3/hour).

FORMULAE

$$Q = AC \sqrt{mi}$$

Where C = Chezy's constant, m = hydraulic mean depth, i = slope

Hydraulic mean depth, $m = \frac{A}{P}$ where A = area of flow, P = wetted perimeter

$C = \frac{1}{N} m^{\frac{1}{6}}$ where N = Manning's n value

Average daily demand = P x q (lpcd)

Maximum daily demand = 1.8 x P x q (lpcd)

Maximum hourly demand of the maximum day = 1.5 x Maximum Daily Demand

Where, P = population, and q = per capita water demand

Geometric Increase, $P_n = P_0 (1 + r)^n$

Linear Increase, $P_n = P_0 (1 + rn)$

Where, r = rate of change, and n = number of years

Principle of continuity of flow, $Q_1 = Q_2 = v \times A$

TASHI DELEK