# Assignments
# for
# Engineering Hydrology
# (BE05006021)

## B.E. Semester 5th (Civil Engineering)

**Government Engineering College,**
**Dahod**

**Directorate of Technical Education**
**Gandhinagar, Gujarat**

## Vision Statement of the Institute

To be a value-based engineering institute to disseminate globally acceptable education and nurturing research, innovation and entrepreneurship.

## Mission Statements of The Institute

1. To provide quality education in the engineering disciplines through creative balance of academics and extracurricular programs.
2. To provide learning environment for innovation and entrepreneurship.
3. To disseminate ethical values, social values and sensitivity towards environmental issues.

## Vision Statement of the Civil Engineering Department

To be a recognized department in the field of civil engineering education to produce professional civil engineers, innovators and entrepreneurs for the development of the society.

## Mission Statements of the Civil Engineering Department

1. To provide quality education to civil engineering undergraduates through creative balance of academic, professional and extra-curricular activities.
2. To impart knowledge in the field of civil engineering for the development of infrastructure facilities with environmental concern for betterment of the society.
3. To contribute in the nation's development through innovative ideas in the field of civil engineering.

## Knowledge and Attitude Profile

- **WK1**: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2**: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline
- **WK3**: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4**: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5**: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area
- **WK6**: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

- **WK7**: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development
- **WK8**: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues
- **WK9**: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes

## Program outcomes (Pos).

- **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).
- **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).
- **PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).
- **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).
- **PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9: Communication:** Communicate effectively and inclusively within the engineering

community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

- **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these in multidisciplinary environments.
- **PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

## Program Specific Outcomes (Psos)

Program Specific Outcomes (PSOs) are what the graduates of a specific undergraduate engineering program should be able to do at the time of graduation.

Civil Engineering Graduates Shall Have

- **PSO 1:** Ability to analyze, design, construct, maintain and rehabilitate the infrastructural projects, using the knowledge of subjects related to planning, construction, structural analysis and design, surveying, geotechnical, transportation, environment and water resource engineering as well as project management.
- **PSO 2:** Ability to employ advanced civil equipments, software, and techniques, interact and work seamlessly in teams.
- **PSO 3:** Ability to apply gained knowledge to choose from the innovative career paths, to be an entrepreneur, and a zest for higher studies.

## Program Educational Objectives (PEOs)

Program Educational Objectives (PEOs) describe the career and professional accomplishments that programs are preparing graduates to attain within a few years (3-5 years) of graduation.

Following are the PEOs of B.E Civil Engineering Program:

- **PEO 1:** Establish themselves as civil engineering professionals in government, public and private sectors.
- **PEO 2:** Manage infrastructural and sanitary facilities.
- **PEO 3:** Solve real world problems environmental concerns to serve society.
- **PEO 4:** Adapt to changing trends in analysis and design of civil engineering structures.
- **PEO-05:** To do testing, survey and planning of civil engineering structures using modern tools.

# Government Engineering College, Dahod

## Certificate

This is to certify that Mr./Ms. _____ _____ Enrollment No. _____ of B.E. Semester Civil Engineering of this Institute (GTU Code: ____ ) has satisfactorily completed the Practical/Assignment work for the subject **Engineering Hydrology (BE05006021)** for the academic year 2026-27.

Place: _____

Date: _____

**Name and Sign of Faculty member**

**Head of the Department**

**Civil Engineering**
**GTU Course Code: BE05006021**

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## Course Outcome matrix

| | |
|---|---|
| **CO-1** | Comprehend hydrological cycle, precipitation processes, and measurement techniques. |
| **CO-2** | Analyze infiltration, evaporation, and runoff processes in a watershed |
| **CO-3** | Apply unit hydrograph and flood routing methods for hydrological analysis |
| **CO-4** | Estimate flood discharge using empirical and statistical methods. |
| **CO-5** | Evaluate groundwater flow and well hydraulics for sustainable usage. |

| Sr. No. | Assignment | CO1 | CO2 | CO3 | CO4 | CO5 |
|---|---|---|---|---|---|---|
| 1. | Introduction to Hydrology | √ | | | | |
| 2. | Precipitation Measurement and Analysis | √ | | | | |
| 3. | Hydrologic Abstractions | | √ | | | |
| 4. | Stream Flow and Hydrograph Analysis | | | √ | | |
| 5. | Watershed Management | √ | √ | √ | √ | √ |
| 6. | Groundwater Hydrology | | | | | √ |
| 7. | Flood Routing | | | √ | √ | |

# Index
## (Progressive Assessment Sheet)

| S. No. | Name of Assignment | Page No. | Starting Date | Date of completion | Marks | Sign. of Teacher with Date | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | Introduction to Hydrology | | | | | | |
| 2. | Precipitation Measurement and Analysis | | | | | | |
| 3. | Hydrologic Abstractions | | | | | | |
| 4. | Stream Flow and Hydrograph Analysis | | | | | | |
| 5. | Watershed Management | | | | | | |
| 6. | Groundwater Hydrology | | | | | | |
| 7. | Flood Routing | | | | | | |
| **Total** | | | | | | | |

## Assignment-1 Introduction to Hydrology

1. Define hydrology and explain its scope and applications in civil engineering.
2. Discuss the importance of the water budget equation in engineering hydrology.
3. A watershed receives 920 mm of annual precipitation. Annual runoff is 300 mm, and annual evapotranspiration is 450 mm. Determine the annual change in storage.
4. List the different forms of precipitation. Discuss the different types of precipitation.
5. Explain the working principle, advantages, and limitations of the Symons rain gauge.
6. Describe the construction and working of a tipping bucket rain gauge.
7. Compare recording and non-recording rain gauges.
8. Discuss the factors affecting the accuracy of rainfall measurements.
9. Compare the Arithmetic Mean, Thiessen Polygon, and Isohyetal methods for estimating mean rainfall.
10. A city experiences frequent urban flooding. Discuss how precipitation data can be used to improve stormwater drainage design.
11. Explain why the Isohyetal method is generally considered more accurate than the Arithmetic Mean method for estimating mean areal rainfall.
12. The following data are obtained from an isohyetal map. Find the average rainfall using Arithmetic Mean, and Isohyetal method

| Isohyets (mm) | Mean Rainfall (mm) | Area ($km^2$) |
|---|---|---|
| 20–40 | 30 | 25 |
| 40–60 | 50 | 40 |
| 60–80 | 70 | 30 |
| 80–100 | 90 | 15 |

13. A catchment is in the shape of an equilateral triangle having a side length of 90 km. Rain gauges are located at the three vertices and one at the centroid of the triangle. The rainfall recorded at the four stations is 85 mm, 95 mm, 100 mm, and 90 mm, respectively. Determine the average rainfall over the catchment using:

a) Arithmetic Mean Method

b) Thiessen Polygon Method

Compare the results obtained by the two methods and comment on the suitability of each method.

**Assignment-2 Precipitation Measurement and Analysis**

1. Discuss the relationship among rainfall intensity, duration, and frequency
2. Explain the temporal and spatial variability of precipitation.
3. Describe the Double Mass Curve method for checking the consistency of rainfall records with a neat sketch.
4. List the instruments used for snow measurement. Explain the concept of Snow Water Equivalent (SWE).
5. Discuss the various methods of predicting missing rainfall data. The rainfall recorded at three surrounding stations A, B and C during a storm were 60, 80 and 60 mm respectively. The fourth rain-gauge, 'D' was inoperative during this specific storm. If the average rainfall of stations A, B, C and D are 520, 870, 680 and 720 mm respectively, estimate the storm rainfall of station 'D' using appropriate method as above.
6. Discuss the World Meteorological Organization (WMO) recommendations for rain gauge network density.
7. Give the optimum number of rain-gauges in a basin, so as to limit the error, in the mean value of rainfall in the catchment, to 10 %.

   Existing station = 5 Nos

   Average rainfall at stations are = 850, 650, 540, 480 and 410 mm.
8. What type of rainfall data is required for DAD analysis? Explain the concept of Depth–Area–Duration (DAD) analysis.
9. A storm covers areas of 100, 250, 500, and 1000 km² with corresponding average depths of 180, 150, 125, and 95 mm. Draw the DAD curve.
10. The following annual rainfall data are available for Station **X** and the average rainfall of nearby stations are as below. Check the consistency of the rainfall data.

| Year | Average Rainfall of Nearby Stations (mm) | Rainfall at Station X (mm) |
|---|---|---|
| 2024 | 700 | 690 |
| 2023 | 720 | 715 |
| 2022 | 740 | 730 |
| 2021 | 750 | 700 |
| 2020 | 760 | 720 |
| 2019 | 800 | 730 |

**Assignment-3 Hydrologic Abstractions**

1. Define hydrologic abstraction. State the importance of hydrologic abstractions in runoff estimation.
2. An agricultural land has been converted to forest land. Discuss the expected changes in interception, depression storage, infiltration, and runoff.
3. Differentiate between climatic and physical factors affecting evaporation.
4. Discuss the various factors affecting infiltration with suitable examples.
5. Describe the Colorado Sunken Pan method for measuring evaporation. Discuss its advantages over the Class A pan method.
6. A Class A evaporation pan records an evaporation of 8 mm/day. The pan coefficient is 0.70. Calculate the evaporation from the reservoir.
7. Describe the factors affecting evapotranspiration.
8. Compare potential evapotranspiration (PET) and actual evapotranspiration (AET).
9. Explain the Green–Ampt infiltration model and its assumptions.
10. The following data are available for a reservoir:

    Inflow = 12 million m³
    Outflow = 8 million m³
    Rainfall over reservoir = 1.5 million m³
    Seepage loss = 0.5 million m³
    Increase in storage = 3 million m³

    Estimate the evaporation loss from the reservoir using the water budget equation.

11. Draw and explain the typical infiltration rate versus time curve.
12. A lysimeter has

    Rainfall = 45 mm
    Irrigation = 30 mm
    Drainage = 12 mm
    Change in soil moisture = 8 mm increase
    Surface runoff = 5 mm

    Calculate evapotranspiration.

13. Explain Horton's infiltration model as below and calculate the infiltration rate after 2 hours.

$$f = f_c + (f_0 - f_c)e^{-kt}$$

Given:

$f_0 = 80\text{mm/hr}$

$f_c = 15\text{mm/hr}$

$k = 0.55hr^{-1}$

**Assignment-4 Stream Flow and Hydrograph Analysis**

1. Distinguish between surface runoff, interflow, and base flow.
2. Discuss the various factors affecting runoff generation.
3. Which method is commonly used for runoff estimation in small catchments?
4. State the different methods used for measuring stream flow. Explain the procedure for measuring stream discharge using the velocity-area method.
5. Discuss the impact of climate change on runoff generation and stream flow.
6. Explain the Importance and Applications of Rating Curves in Hydrological Studies
7. Explain the different methods of base flow separation with suitable sketches.
8. Explain the procedure for developing a synthetic unit hydrograph and discuss its applications
9. Classify hydrological models with suitable examples.
10. Discuss the importance of model calibration and validation in hydrological modelling. Explain the steps involved in carrying out these processes.
11. An ungauged watershed has:
    - Area = 280 km²
    - Basin lag = 15 hr
    - Snyder coefficient $C_p = 0.60$

Estimate the peak discharge and discuss the applicability of Snyder's Synthetic Unit Hydrograph.

12. Given below are the ordinates of a unit hydrograph for a storm of 4 hr duration. Find ordinates of flood hydrograph when the maximum flood observed was 4000 $m^3$/sec and base flow was 250 $m^3$/sec.

| Time (hrs) | 0 | 4 | 8 | 12 | 16 | 20 | 24 |
|---|---|---|---|---|---|---|---|
| Surface runoff (cumecs) | 0 | 1500 | 1300 | 670 | 200 | 80 | 0 |

13. A 2-hour Unit Hydrograph (UH) for a watershed has the following ordinates:

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|
| UH ($m^3/s$) | 0 | 20 | 50 | 35 | 15 | 5 | 0 |

Estimate the Direct Runoff Hydrograph (DRH) produced by 4 cm of effective rainfall of 2-hour duration.

14. The ordinates of a 2-hour Unit Hydrograph (UH) for a watershed are given below.

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| Discharge ($m^3/s$) | 0 | 15 | 40 | 70 | 50 | 30 | 15 | 5 | 0 |

Using the S-curve (Summation Hydrograph) method, derive the 6-hour Unit hydrograph for the same catchment.

15. The ordinates of a 1-hour Unit Hydrograph are:

| Time (hr) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| UH ($m^3/s$) | 0 | 15 | 38 | 35 | 30 | 25 | 22 | 15 | 0 |

Determine the Direct Runoff Hydrograph for 3 cm of effective rainfall. Assume constant base flow of 15 $m^3/s$.

16. The direct runoff resulting from a 5.0 cm effective runoff of 6 hr duration is given below. Determine the area of catchment and the ordinate of the 6 hr unit hydrograph.

| Time in (hr) | 0 | 6 | 12 | 18 | 24 | 39 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direct runoff ($m^3$/sec) | 0 | 25 | 180 | 300 | 320 | 310 | 200 | 170 | 100 | 70 | 25 | 15 | 0 |

**Assignment-5 Watershed Management**

1. Differentiate between a watershed and a river basin. Discuss the major physical characteristics of a watershed.
2. A watershed has a maximum basin length of 30 km, the total length of all streams is 350 km. and an area of 180 $km^2$. Calculate the form factor and drainage density of the basin.
3. Describe the Universal Soil Loss Equation (USLE) and explain each of its parameters.
4. Discuss how watershed management techniques help in controlling soil erosion and reducing sedimentation within a watershed.
5. A Watershed has a Curve Number (CN) of 75 and receives 100 mm of rainfall. Calculate:
   a) Potential maximum retention (S)
   b) Initial abstraction (Ia)
   c) Direct runoff (Q)
6. Explain the impact of urban development on soil erosion.
7. Discuss the non-structural measures used for watershed management with neat sketches.
8. Discuss the role of watershed management in achieving SDG 13 (Climate Action) and SDG 15(Life on Land)
9. Discuss the different types of droughts and explain their environmental and socio-economic impacts.
10. Recommend suitable engineering measures for drought management in semi-arid regions.
11. Explain the concept and objectives of watershed simulation.
12. Differentiate between conceptual, empirical, and physically based watershed models.
13. Discuss the Importance of Watershed Simulation in Integrated Watershed Management.

**Assignment-6 Groundwater Hydrology**

1. Explain the occurrence of groundwater in different geological formations.
2. Define an aquifer and explain the following types of aquifers with neat, labelled diagrams:
    a) Unconfined aquifer
    b) Confined aquifer
    c) Semi-confined (Leaky) aquifer
    d) Perched aquifer
3. Differentiate the following
    a) Aquifer
    b) Aquitard
    c) Aquiclude
    d) Aquifuge
4. Differentiate between: a) Hydraulic Conductivity (K) and Transmissivity (T) b) Specific Yield (Sy) and Specific Retention (Sr)
5. A pumping test indicates high transmissivity but low storage coefficient. What does this reveal about the aquifer type?
6. Derive the Darcy equation for groundwater flow through a saturated porous medium. Discuss the assumptions and limitation of Darcy's Law.
7. An aquifer of 25 m average thickness is overlain by an impermeable layer of 30m thickness. A test well of 0.5 m dia and two observation wells at a distance of 10 and 60 m from the test well are drilled through the aquifer. After a long period of pumping at a rate of 0.1 $m^3$/sec, the drawdowns in the wells at 10 m and 60 m are 4 m and 3 m, respectively. Determine the transmissibility of the aquifer and drawdown in the pumped well?
8. An unconfined aquifer has thickness of 30 m. A fully penetrating 20 cm diameter well in this aquifer is pumping at a rate of 40 lit/s. The drawdown measured in two observation wells located at distances of 10 m and 100 m from the well are 7 m and 0.5 m respectively. Determine the average hydraulic conductivity of the aquifer. At what distance from the well the drawdown is insignificant?
9. During a recuperation test, the water in an open well was depressed by 2.5 m due to pumping and it recuperated 1.8 m in 80 minutes. Calculate the yield from a well 4 m diameter under a depression head of 3 m.
10. Define groundwater flow modelling. Discuss the importance of groundwater flow models in sustainable groundwater management.
11. Explain the importance of hydrogeological surveys in groundwater exploration and development.

12. Explain the working principle, advantages, limitations, and applications of any two geophysical surveys Method.
13. Define groundwater quality and explain its importance in water resource management.
14. Explain the importance of contaminant transport modelling in groundwater engineering.
15. State the Ghyben–Herzberg principle. Derive/Explain the relationship between freshwater head and the depth of the freshwater–saltwater interface.
16. Discuss different methods used to prevent or control seawater intrusion.

## Assignment-7 Flood Routing

1. Define flood routing and explain its objectives and applications in Engineering Hydrology.
2. Explain the governing equations used in flood routing with suitable derivations.
3. Differentiate between:
   a) Hydrologic routing and Hydraulic routing
   b) Reservoir routing and Channel routing
4. Explain the Modified Puls (Storage Indication) method used for reservoir flood routing with a neat flow chart.
5. Determine the routed outflow hydrograph for the following reservoir data using the Modified Puls Method:

| Water Level | Storage ($Mm^3$) | Outflow ($m^3/s$) |
|---|---|---|
| 100 | 15 | 80 |
| 101 | 18 | 100 |
| 102 | 22 | 130 |
| 103 | 27 | 170 |
| 104 | 33 | 220 |

The inflow hydrograph is:

| Time (hr) | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Inflow ($m^3/s$) | 80 | 180 | 320 | 250 | 160 | 80 |

**Q6.** Describe the Muskingum method of hydrologic routing. Explain the significance of parameters K and X.

**Q7.** A river reach between two towns experiences a flood due to continuous rainfall. The downstream town is vulnerable to flooding. Route the flood hydrograph using Muskingum method and comment on how the peak discharge changes after routing.

Given:

- Storage constant, K = 6 h
- Weighting factor, X = 0.25
- Time interval, $\Delta t$ = 3 h

The upstream inflow hydrograph is:

| Time (h) | 0 | 3 | 6 | 9 | 12 | 15 |
|---|---|---|---|---|---|---|
| Inflow ($m^3/s$) | 60 | 150 | 320 | 260 | 140 | 70 |

**Q 8.** Discuss the applicability and limitations of the following flood estimation methods.

- Rational Method
- Empirical Formulae

- Unit Hydrograph Method
- Flood Frequency Method

**Q 10.** A municipal corporation is planning a stormwater drainage system for a rapidly urbanizing area. Which flood estimation method will you adopt for determining the design flood for this project and why? Suggest two measures to reduce urban flooding in the area.

**Q 11.** A stormwater drainage system is to be designed for a newly developed urban area having a catchment area of 150 ha. The runoff coefficient is 0.75, and the rainfall intensity corresponding to the time of concentration is 90 mm/h. Estimate the peak flood discharge using the Rational Method.

Q 12. A bridge is designed for a flood magnitude of return period 100 years and has an expected life of 25 years.

i) What is risk of this hydrologic design

ii) If a risk of 15% is acceptable, what return period will have to be adopted?

**Q 13.** The annual peak flood discharges ($m^3/s$) recorded over 10 years are:

| Flood ($m^3/s$) | 780 | 740 | 710 | 680 | 640 | 610 | 590 | 560 | 520 | 480 |
|---|---|---|---|---|---|---|---|---|---|---|

Compute the return period using Weibull's Formula. Estimate the probability of occurrence of each flood.

**Q14.** A state irrigation department plans to upgrade an existing dam. The annual maximum flood discharges ($m^3/s$) recorded over ten years are: Estimate the 50-year return period flood using Gumbel's method.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Peak Flood ($m^3/s$) | 520 | 610 | 580 | 700 | 660 | 740 | 690 | 630 | 770 | 720 |

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