

लोक सेवा आयोग  
नेपाल इन्जिनियरिङ्ग सेवा, सिभिल समूह, हाइड्रोलोजी उपसमूहको राजपत्राङ्कित तृतीय श्रेणी पदको  
खुला र आन्तरिक प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

द्वितीय पत्र :- हाइड्रोलोजी सम्बन्धी विषय

- 1. Hydrological observations (instruments and methods) 20%**
  - 1.1. Precipitation: gauge location; non-recording and recording gauges; snowfall measurement; observations by satellite
  - 1.2. Snow cover: water equivalent; depth and extent of snow cover; ground surveys; radioisotope snow gauges; snow pillows; natural gamma radiation
  - 1.3. Evaporation and evapotranspiration: pan evaporation; soil evaporimeters; lysimeters; snow evaporimeters; short and long wave radiation; indirect methods
  - 1.4. Water levels of rivers, lakes and reservoirs: gauges and procedures for measurement of stage; frequency of stage measurements
  - 1.5. Discharge measurements : current meters; float method; dilution method; ultrasonic method; electromagnetic method; indirect methods; measurement under ice cover
  - 1.6. Stream gauging stations: selection of site; control sections; stage-discharge relationships
  - 1.7. Water temperature: infra-red radiation thermometer; measurement of water surface temperature for lake and reservoir evaporation
- 2. Design of hydro-meteorological network 5%**
  - 2.1. General principles for design of networks: general requirements; optimum network; minimum network; optimum use of existing stations in organizing a minimum network; data to be considered in determining network density; quality of data to be collected
  - 2.2. Density of observation stations for a minimum network: factors affecting the density; minimum density limit of climatological networks; hydrometric network of minimum density
  - 2.3. Integration of bench-mark stations and representative basins in the network
- 3. Collection, processing and publication of hydro-meteorological data 10%**
  - 3.1. Collection: observational procedures; transmission of hydrological observations; quality control; storage of data
  - 3.2. Special data collection: weather radar data and extreme rainfall; extreme river stages and discharges
  - 3.3. Stream flow computation: computation of average gauge height; computation of average discharge; computation of average discharge under ice cover; quality control of stream flow data; data processing through computer software
  - 3.4. Publication: purposes; requirements of hydrology; frequency of publication; contents and formats
- 4. Hydrological analysis 30%**
  - 4.1. Catchment characteristics and their effects to surface runoff
  - 4.2. Interpretation of precipitation data: adjustment of data, double-mass curve analysis, evaluation of physiographic effects; average depth over a catchment; storm rainfall studies; depth-area-duration analysis, probable maximum precipitation (PMP); rainfall frequencies; drought severity; rainfall intensities
  - 4.3. Interpretation of stream flow data: adjustment of data; spatial distribution, maps of average annual run-off; temporal distribution of runoff volume, unit hydrograph, stream flow routine, low flow analysis, flow duration curves, low flow frequencies, statistical analysis of droughts, recession curve analysis, flood frequencies, statistical analysis of floods, regional generalization of flood characteristics; long period trends

- 4.4. Evaporation and evapotranspiration: water budget method, energy budget method aerodynamic approach, combination of aerodynamic and energy balance equations, pan coefficient method
- 4.5. Runoff relations with rainfall and snowmelt: regressions analysis; runoff by storm periods, antecedent-moisture index method, initial base flow as index to rainfall runoff, moisture accounting techniques; runoff from short period snowmelt; monthly, seasonal and annual water budget
- 4.6. Hydrological analysis: estimation of required reservoir storage capacity, multipurpose storage requirements; reservoir system design; environmental effects.
- 4.7. Design of urban and small rural watershed drainage works: regional method; unit hydrograph and time area curves; distributed system models; rainfall data required for design of drainage works
- 4.8. Influences of hydrological factors on water quality : general causes of water quality changes, reaction to pollutants; eutrophication; self-purification; absorption and accumulation; rise in water temperature
- 5. Sediment measurement techniques and analysis 10%**
  - 5.1. Source of sediment; geo-morphology of rivers; seasonal variation of sediment load; types of sediment; physical and chemical characteristics of water (turbidity, color, conductivity etc.)
  - 5.2. Measurement of sediment; bed load; suspended load
  - 5.3. Sediment yields; sediment yield modeling; Musgrave equation; Universal Soil-Loss Equation (USLE); runoff-sediment relation; sediment concentration graph; unit sediment graph; reservoir and lake sedimentation
  - 5.4. Estimation of bed load and suspended load; estimation of sediment load in the absence of local data
- 6. Ground water hydrology 10%**
  - 6.1. Occurrence and distribution of ground water; geological formations (aquifers, aquicludes; aquitards); artesian - gravity well
  - 6.2. Flow equations for confined and unconfined aquifers; Dupit's assumption
  - 6.3. Water wells and their types; testing of wells
  - 6.4. Well hydraulics; Darcy's law; permeability; steady and unsteady flow; specific capacity and well efficiency; well losses
  - 6.5. Soil moisture: weight method and electrical resistance method
- 7. Snow and glacial hydrology 5%**
  - 7.1. Formation of snow and ice; methods of observation
  - 7.2. Basic concept of glaciers, variation of glaciers, process of snow and glacier melting; monitoring of glaciers
  - 7.3. Glacier Lake Outburst Floods (GLOFs)
- 8. Hydrological forecasting 10%**
  - 8.1. Hydrological forecasts and warnings: classification of hydrological forecasts, types of warnings
  - 8.2. Hydrological forecasting services: operation; organization; collection of data and issue of forecasts and warnings; data requirements accuracy and frequency of data measurements, operational data acquisition, use of radar observations for hydrological forecasting, use of snow and ice observations from meteorological satellites, technical equipment for hydrological forecasting services
  - 8.3. Forecast method: seasonal and annual flow forecasts; stages and flows, flood forecasts, rainfall runoff computations, conceptual catchment models, stream flow simulation; short and long term forecasts of ice formation and break up

8.4. Evaluation and verification of hydrological forecasts: formulation of hydrological forecasts; evaluation of forecasting method; verification of operational forecasts; relation between meteorological and hydrological forecasting; benefit-cost analysis for hydrological forecasting

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### विषयगत नमूना प्रश्नहरू (Sample questions)

1. Describe different types of rain gauges. What are the errors associated with precipitation measurement?
2. Describe the procedure to design the network of precipitation for a watershed.
3. In water resources planning, stream flow records are needed. Why do we use rainfall to arrive at the stream flow indirectly? Why do we use rainfall instead of any other climatic data for the above purpose?
4. Discuss the importance of data in hydrology. Explain the types of hydrologic data.
5. Explain the use of statistics in hydrologic analysis.
6. What is probability? Explain the rules of probability.
7. What return period of flood should a water resources engineer adopt in the design of a storage dam with an expected life of 100 years if he is willing to accept only a 10% flooding?
8. Define correlation, multiple correlation and regression. Give different measures of correlation between two different variables.
9. Discuss hydrograph concept. How is the hydrograph shape affected by various factors? Explain these factors.
10. Explain the watershed characteristics that affect the nature of stream flow.
11. What is unit hydrograph? How does it permit the conversion of rainfall to runoff?
12. What is an S-hydrograph? Explain the use of the S-hydrograph in hydrologic analysis.
13. Discuss different factors affecting snowmelt runoff.
14. What is infiltration? Discuss the mechanics of infiltration and the factors affecting the infiltration rate.
15. Estimate the monthly change in storage of a lake with an area of 150 ha when the inflow during the period of one month is 1 cumec, the outflow 0.8 cumec and the total seepage loss 2 cm. The total monthly precipitation is 3 cm and the evaporation loss 8 cm.
16. Define the terms: Aquifer, unconfined aquifer, confined aquifer, leaky aquifer, porosity, specific yield, specific retention, storage coefficient and transmissibility.
17. What is Darcy's law? Explain the use of this law in the present-day theoretical solutions to the problem of ground water movement.
18. Prove the Laplacian equation for unsteady-state ground water flow.
19. What is a flow net? How is it made use of in computing the quantity, rate and direction of groundwater flow?
20. Describe the various methods of measuring the velocity of a stream. Which of these methods can be used during high flood and what are the limitations of using this?
21. Why is the stage-discharge relationship important in hydrologic analysis? What are the different methods of extending the stage-discharge relationship?
22. Why is it necessary to extend the stream flow record in hydrologic analyses? Describe one of the methods suitable for extending a hydrologic record in the context of Nepal.
23. Describe the procedure of extending the stream flow data with the precipitation data. What different cases we come across in the field with regard to availability of precipitation records?
24. Define "design flood". How would you estimate the design flood for an ungauged watershed? Discuss in brief the different methods available for the purpose.
25. What is "flood-frequency analysis"? How do you determine the design frequency for a desired degree of risk?
26. What is Gumbel's distribution? Why does it plot as a straight line on an extreme value probability paper? How do you plot a confidence band on this line?

27. What is “probable maximum flood”? List out the steps you would take as a hydrologist in evaluating the probable maximum flood for a project.
28. Discuss in brief the problems associated with flood forecasting. What are the different methods of flood forecasting? Discuss them in brief.
29. The data available at the project site is short. How would you extend this data to get a better estimate of the water availability of the project?
30. How would you estimate silt load for a reservoir by the method of sediment sampling at site? Discuss in brief the methods of measuring the suspended sediment load and the bed load.
31. Describe history of development of hydrologic study in Nepal. Give two examples of engineering problems where hydrologic knowledge is necessary to obtain a solution.
32. What are the two properties of a good rating curve? Describe the two types of control in open channel flow. How does control affect the rating? Explain briefly.
33. Discuss the concepts of linearity and superposition in connection with unit hydrograph theory. What is the difference between superposition and S-hydrograph methods to change unit hydrograph duration?
34. What hydrologic processes does the rational method account for? Explain how they affect runoff.
35. What is the slope-area method? When is it used? What is the recommended minimum to preserve accuracy?
36. What is the risk in the context of frequency analysis? How is an extreme value probability paper constructed?
37. Enumerate the methods that are used for determining the yield of dug wells. Discuss briefly any one of the methods.
38. Derive a formula for discharge of well in a homogeneous artesian aquifer, assuming equilibrium flow conditions.
39. Describe different methods of recharging the ground water reservoir. Discuss briefly as to how the water is stored into the ground water reservoir.
40. Explain with sketch the important hydro-geomorphological characteristics of rivers.
41. Explain the methods and procedure of collecting hydrological data. How the collected data should be processed?
42. List out the observation techniques of hydrological characteristics. What types of instruments are used for such observations?
43. Suggest the optimum design of hydrological and meteorological network in the different topographical regions (High Mountains, Hills and Terai) of Nepal.
44. What do you understand by a GLOF? What is its importance in the hydrologic study of a project?
45. Briefly describe about the flood forecasting models. Which of them do you suggest suitable in the context of Nepal.