

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Ground Water Engineering (*Elective II*) (CE76509)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Semi log graph should be given.
- ✓ Assume suitable data if necessary.

1. a) Explain in brief hydrological cycle focusing on components of subsurface movement of water. [4]
 b) Write about the major zones of soil layers according to the presence of types of water in it. List out the types of spring. [4+2]
2. a) Define Representative Elementary Volume Approach (REV) and continuum Approach of analysis. Explain about the importance, validity and limitation of Darcy Law in ground water motion. [6]
 b) A geotechnical investigation site has fully penetrating well in a confined aquifer of 18 m thick. Pumping out test has been performed at a constant rate of $0.3 \text{ m}^3/\text{s}$. Sieve analysis of aquifer material gave average grain diameter 1 mm. Determine valid domain around the well for which Darcy's law? Assume that Darcy's law is valid up to Reynold's no. (Re) of 8 and kinematic viscosity of water = 1 centistoke. [6]
3. a) Define flow net with neat sketch. What are the applications of flow net in geotechnical engineering? Derive the expression for determining seepage discharge from flow net. [3+3+4]
 b) Two irrigation canals are separated by a land strip of 1.57 km underlain by a horizontal impervious layer of rock (unconfined). The maximum rate of rainfall is 25 mm/hr on that land strip. The depth of water in the two canals are 12 m and 7 m. Determine the maximum seepage discharge per meter length of the canal into both canals, assuming coefficient of permeability of strip as 12 m/day with vertical boundaries, and all rainfall infiltrates into the soil. Also determine the equation to the phreatic surface and the water table divide. [8]
4. a) Define the terms cone of depression, radius of influence, well yield and specific capacity of well yield. Write down the assumptions for this equation. [6]
 b) A 30 cm diameter well penetrates an artesian aquifer, 23 m thick. Determine the maximum yield from this well for a drawdown of 3.5 m. Assume $K = 2.8 \times 10^{-4} \text{ m/s}$ and radius of influence of 450 m. Also determine the percentage increase in discharge, if the diameter of the well is decreased to 20 cm, the other conditions remaining the same. [6]

5. a) Write down step to step procedure to determine transmissivity (T) by Thiem's Method with necessary mathematical expression. [4]

- b) In a pumping test site of a confined aquifer with a uniform pumping rate of $1000 \text{ m}^3/\text{day}$, the drawdown measured in an observation well located at a distance of 100 m from a test well is measured as below:

Time (days)	0.001	0.005	0.01	0.05	0.1	0.5	1	5	10
Drawdown (m)	0.083	0.196	0.249	0.376	0.431	0.559	0.614	0.742	0.797

Calculate transmissivity (T) and storage coefficient (Sy) of the aquifer by using Cooper-Jacob method. [6]

6. Explain about factors to be considered in the selection of pump sets for pumping of groundwater. [4]
7. For the irrigation project planned in Dhangadi by groundwater pumping, a recuperation test was conducted on an open well. The water level in the well was depressed by 4 m and it was left to raise by 2.2 m in 90 minutes. Calculate the specific yield of open well in that region. Also determine the yield from a well of 5 m diameter under a depression head of 2.5 m? [6]
8. Discuss about the overall condition of exploitation of groundwater in urban area with reference to Butawal and its mitigation measures. [4]
9. What are the geophysical methods for the groundwater exploration? Write in detail of any of them. [4]

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INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Ground Water Engineering (*Elective II*) (CE76509)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) State the advantages of groundwater in comparison to surface water. [2]
b) With the help of neat sketch briefly discuss various subsurface zones. [4]
2. a) What do you understand by the Continuum and Representative elementary Volume approach in groundwater flow analysis? Define Permeability and Transmissibility. [4+2]
b) A fully penetrating well is pumped at constant rate of 1000 m³/hr from confined aquifer of 28 m thick and average grain diameter of 1 mm. What is the domain around the well for which Darcy's law is applicable? Assume Darcy's law is valid up to Reynold's no (Re) = 6 and Kinematic viscosity of water = 1 centistokes. [8]
3. a) State the uses of water table contour. Prepare a water table contour map and show the direction of groundwater flow from four observation wells (water table elevation in wells: 51m, 56m, 76m and 66m) located at the vertex of a rectangle. Take the contour interval of 5m. [3+4]
b) Two rivers are separated by a homogeneous unconfined aquifer of 5 km long. Given the depth of aquifer at river channels as 20 m and 11 m, compute the seepage flow per unit length of the river. Coefficient of permeability, K = 18 m/day. Also give the equation of phreatic line. [7]
4. a) Derive an Expression for equation of steady radial flow into a well in confined aquifer with neat sketch. [7]
b) A well with a radius of 0.5m, completely penetrates an unconfined aquifer of thickness 50 m and K = 30 m/day. The well is pumped so that the water level in the well remains at 40 m above the bottom. Assuming that pumping has essentially no effect on water table at a distance of 500 m from the center of the well, compute the steady-state discharge. [4]
5. a) Why is the pumping test carried out in ground water? [2]
b) The drawdown measured in an observation well located at a distance of 100 m from a pumped well is recorded below:

t (days)	0.001	0.005	0.01	0.05	0.1	0.5	1	5	10
Drawdown(m)	0.083	0.196	0.249	0.376	0.431	0.559	0.614	0.742	0.797

The well is in confined aquifer and the uniform pumping rate from the well is 1000 m³/day. Determine the aquifer parameters transmissivity (T) and storage coefficient (S) by using Cooper-Jacob method.

[8]

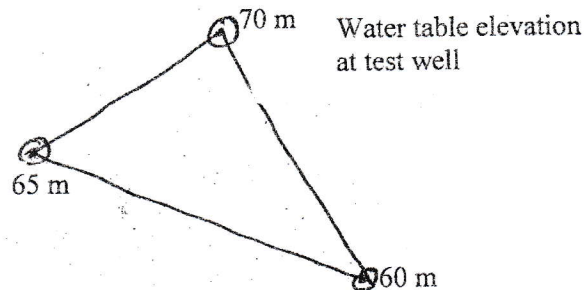
6. Discuss briefly the purpose of groundwater exploration. Explain with necessary sketches the Electrical Resistivity method of geophysical exploration. [2+3]
7. a) Differentiate between open well and tube well. [3]
- b) During a recuperation test conducted on an open well in a region, the water level in the well was depressed by 3m and it was observed to rise by 1.75m in 75 minutes.
- (i) What is the specific yield of open wells in that region?
- (ii) What could be the yield from a well of 5 m diameter under a depression head of 2.5 m?
- (iii) What should be the diameter of the well to give a yield of 12 lit/s under a depression head of 2 m? [2+2+3]
8. Describe in short any four common groundwater pumps. What are the factors to be considered while selecting the groundwater pump? [4+2]
9. Discuss the aquifer system of Kathmandu valley. [4]

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Year / Part	IV / II	Time	3 hrs.

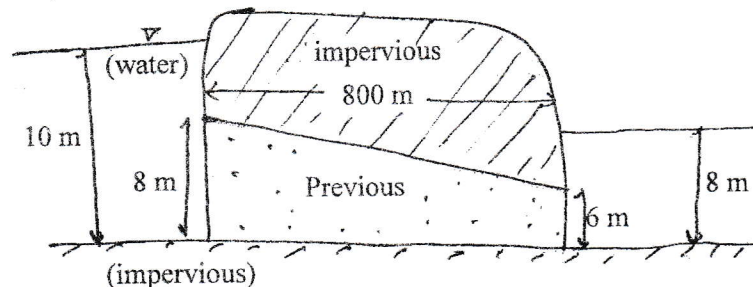
Subject: - Ground Water Engineering (Elective II) (CE76509)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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1. Define specific storage, specific yield, transmissibility and anisotropy of aquifer. [4]
2. Starting from the general expression of Darcy Law for groundwater flow, derive 3D form of groundwater flow. [8]
3. In certain place in Pokhara, the average thickness of confined aquifer is 30 m and extends over an area of 800 km^2 . The piezometric surface fluctuates annually from 19 m to 9 m above the top of the aquifer. Assuming the storage coefficient of 0.0008, what ground water storage can be expected annually? Assuming an average well yield of $30 \text{ m}^3/\text{hr}$ and about 200 days of pumping in a year, how many wells can be drilled in the area? [8]
4. Explain how the water table contour maps are prepared and state their uses. Prepare groundwater contour at interval of 2 m and show direction of groundwater flow in figure below. [6+4]



5. What is the flow in the confined aquiter shown in figure below? (Take $K = 0.4 \text{ m/day}$) [8]



6. The drawdown measured in an observation well located at a distance of 100 m from a pumped well is recorded below: (where, $t \rightarrow$ time)

[8]

t (days)	0.001	0.005	0.01	0.05	0.1	0.1
Drawdown (m)	0.083	0.196	0.249	0.376	0.376	0.431
t (days)	0.5	1	5	10		
Drawdown (m)	0.559	0.614	0.742	0.797		

The well is in a confined aquifer and uniform pumping rate from well is $1000 \text{ m}^3/\text{day}$. Determine transmissivity (T) and storage coefficient (s) by using Copper-Jacob method.

7. What is the main objective of groundwater exploration? List out different methods of surface investigations used in groundwater exploration. What do you mean by water witching. [2+3+1]
8. Discuss about aquifer system of Kathmandu valley of Nepal. [6]
9. Explain the working principle, advantages and limitations of centrifugal pump used for groundwater. [4+2]
10. What do you mean by the tube well? Explain different types of tube well with figure. [1+9]
11. Explain the Theis Solution for determination of storage coefficient and transmissibility of aquifer. [6]

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INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

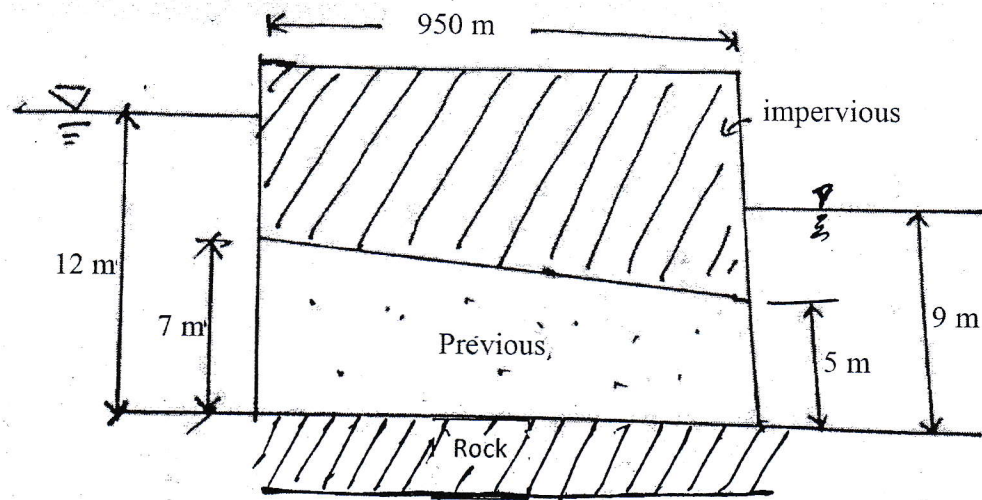
Subject: - Ground Water Engineering (*Elective II*) (CE76509)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a. Define springs, list out the types of springs and explain each of them briefly. [4]
b. Explain the origination of groundwater. How hydrological components effects on groundwater? [6]
2. a. What is Darcy's law for groundwater flow? Derive 3-D form of it and also explain its validity. [8]
b. In Janakpur, confined aquifer has average thickness of 20 m and expand over an area of 850 km². The groundwater table fluctuates annually from 15 m to 10 m above the top of the aquifer. Assuming the storage coefficient of 0.0009, what is expected annual ground water storage? Assuming an average well yield of 30 m³/hr and about 210 days of pumping in a year, how many wells can be drilled in the area? [8]
3. Define cone of depression, radius of influence and area of influence with neat sketch in well hydraulics. [6]
4. a. Explain how water table contour map is prepared. [4]
b. Derive the equation $Q = \frac{\pi K (h_2^2 - h_1^2)}{\ln \left(\frac{r_2}{r_1} \right)}$ for the steady radial flow for unconfined aquifer. Symbols carry their usual meaning. [6]
5. Explain the types of pumping test in field to determine the permeability of soil. [8]
6. Explain Cooper and Jacob method for the determination of storage coefficient and transmissivity of aquifer using time drawdown data. [6]

7. Determine the flow in confined aquifer as shown in figure below. Take $K = 0.56$ m/day.

[8]



8. What are the objectives of groundwater exploration? Explain seismic refraction method of groundwater exploration.
9. Explain working principle of centrifugal pump used for lifting groundwater.
10. Discuss about the groundwater development possibilities of Terai belt.

[6]

[4]

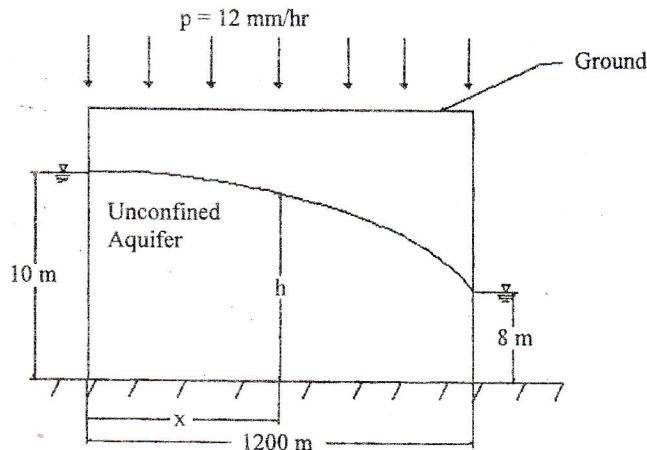
[6]

Exam.	Regular / Back		
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Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Ground Water Engineering (*Elective II*) (CE76509)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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- ✓ Assume suitable data if necessary.

1. What is Groundwater Engineering? What is the importance of Ground water in the context of Nepal? Write the advantages and disadvantages of Ground water. [2+3+3]
2. What do you understand by Representative Elementary Volume (REV)? Explain. [3]
3. Derive an expression for the seepage discharge from flow net for an isotropic aquifer. [8]
4. Rainfall at the rate of 12 mm/hr falls on a strip of land 1200 m wide lying between two parallel canals. It is underlain by a horizontal impervious stratum (unconfined). The depth of water above this stratum in the two canals are 10 m and 8 m. Assuming a permeability of 10 m/day with vertical boundaries, and all rainfall infiltrates into the soil, compute the discharge per m length into both the canals. Determine the equation to the phreatic surface and the water table divide. If there is no rainfall, what would be the seepage to the lower canal? (Refer fig.) [3+3+3]



5. What are Water bearing materials? Explain briefly. [6]
6. In a homogeneous isotropic confined aquifer of constant thickness of 25 m, effective porosity of 20% and permeability of 15 m/day, two observation wells 1100 m apart indicate piezometric heads of 5.5 m and 3 m respectively. Assuming uniform flow, average grain diameter of 1 mm and kinematic viscosity of water = 0.01 cm²/s, state [4+4]
 - a) Whether Darcy's law is applicable?
 - b) What is the average flow velocity in pores?

7. What is Ground Water Exploration? What are the objectives of Groundwater Exploration? Write about methods of Groundwater exploration. [1+1+6]
8. The steady state discharge from a pumping well is $0.025 \text{ m}^3/\text{s}$. Following are the drawdowns obtained from the multiple observation well test of confined aquifer. [10]

r (m)	7	30	60	100	160	200
s (m)	1.3	0.95	0.71	0.535	0.36	0.29

Where r = distance of observation wells from pumping well and s = drawdown. Calculate radius of influence and transmissibility of the aquifer (Semi-log graph is provided).

9. What are the types of pumps used for lifting water? [4]
10. During a recuperation test conducted on an open well in a region, the water level in the well was depressed by 3 m and it was observed to rise by 1.75 m in 75 minutes. [3+3+4]
- What is the specific yield of open wells in that region?
 - What could be the yield from a well of 5 m diameter under a depression head of 2.5 m?
 - What should be the diameter of the well to give a yield of 12 lit/s under a depression head of 2 m?
11. Discuss with the help of schematic zones the availability and possibilities of groundwater resources in Kathmandu Valley. [6]
