

الجامعة التكنولوجية

قسم هندسة البناء والإنشاءات

المرحلة الأولى



العدد : —

التاريخ : ٥١ / ٦ / ٢٠١٥

الى / السيد معاون رئيس القسم

م/ الاجابة النموذجية لمادة (الجيولوجيا الهندسية 2)

تحية طيبة

نرفق لكم طياً نسخة من الأسئلة الخاصة بمادة الجيولوجيا الهندسية 2 و للإمتحان النهائي للفصل الدراسي الثاني - الدور الأول و للعام الدراسي 2014 - 2015 و الذي تم اجراءه بتاريخ 2015/5/31 مع الاجابة النموذجية الخاصة بها.

مع التقدير

أ.م.د. قيس جواد فريح

مسؤول المرحلة الأولى

2015 / 6 / ٥١

نسخة منه الى/

• ملف اللجنة الامتحانية



University of Technology
Engineering Department of Building and Construction
Final Exam First Attempt 2014-2015



Subject: Engineering Geology
Examiner: Engineering Geology Committee
Date: 31 / 05 / 2014

Year: 1st Year
Time: 3 Hours

Answer FOUR Questions Only

Q1. State whether each of the following statements is TRUE or FALSE and correct the FALSE one. (25 Mark)

1. The triaxial compressive strength for determining clay shear strength is $\tau = \sigma_n \tan \Phi$. ✓
2. In shallow depths from earth surface, the horizontal stresses are smaller than the vertical stresses.
3. For the bulk density of rocks, the average must be used because the minerals may be present in different amounts.
4. The driving force and the total friction force in the river become equal when the flow is at a constant velocity. ✓
5. In river meanders, the abandoned bend is called an oxbow lake. ✓
6. The main variations causing variations in river velocity are gradient and shape of the river only.
7. Seismic refraction and electrical resistivity methods geophysical methods to investigate the groundwater. ✓
8. The ground water exists in the zone of aeration.
9. A rock with a high percentage of open spaces has high porosity. ✓
10. Water moves slowly through a clay stratum because the pores are not interconnected.

Q2. A. Fill the blanks with the suitable words. (15 Mark)

1. Depending upon the type of loading and the stresses, the strength may be classified as:-----, ----- and -----.
2. Rivers and streams transport their load of sediments in three ways:-----, ----- and -----.
3. Total precipitation = ----- + ----- + -----.
4. Two types of discharges are presented in rivers; these are ----- and -----.
5. The quality of ground water can be classified according to the total dissolved salts into four types: -----, -----, ----- and -----.

B. Choose the correct answer: (10 Mark)

1. A river's velocity is ----- on the outside meander curve compared to the inside.
a) higher b) equal c) lower
2. A platform of sediment formed where a stream flows into standing water is: a) an alluvial fan
b) a delta c) a meander d) a flood plain
3. Porosity is: a) the percentage of a rock's volume that is voids b) the capacity of a rock to transmit a fluid c) the ability of a sediment to hold water d) none of the preceding
4. The subsurface zone in which all rock openings are filled with water is called the:
a) saturated zone b) water table c) unsaturated zone d) aquiclude
5. For most rocks, Poisson's ratio values are ranging between: a) 0.0-0.5 b) 0.0-0.4 c) 0.1-0.5
d) 0.2-0.3

Q3.A. A sandstone rock has a volume in its natural state of 0.0093 m^3 and weighs 177.6 N . The oven-dried weight of this rock is 153.63 N . If the specific gravity is 2.67 .

Calculate: 1. Moisture content (%) 2. Moist and dry unit weights
3. Void ratio and porosity 4. Degree of saturation **(16 Mark)**

B. Show by sketches only the following items: (9 Mark)

1. The relation between rock constituents (Rock phase relationship).
2. Vertical classification of groundwater.
3. A river meander showing its main parts.

Q4. A. An aquifer has a cross-section with a horizontal width of 265 m , and a vertical thickness below water table of 42 m . The water table is 36 m below ground surface. The discharge at this section is $3340 \text{ m}^3/\text{d}$ and the yield porosity 27.1% .

It is required to find:

- a. the aquifer cross-sectional area
- b. Darcy's velocity
- c. actual velocity of aquifer water

(15 Mark)

B. Answer the following items: (10 Mark)

1. Draw the general change in river characteristic from the head to mouth.
2. List only the main index properties of rocks affecting design and construction in rocks.
3. By sketches show the formation of a cutoff and oxbow lake in meanders.

Q5. A. A river with a width 120 m , depth 7 m , discharge $9065 \text{ m}^3/\text{s}$, gradient 0.002 and roughness coefficient 0.018 . How long is the wetted perimeter, hydraulic radius and the river velocity? **(15 mark)**

B. Answer TWO of the following items: (10 mark)

1. Prove that $e = n / (1 - n)$?
2. Define water table. What are the main characteristics of water table?
3. Differentiate between confined and unconfined aquifers.

.....Good Luck.....

Useful Relations

$$\gamma_{dry} = G \gamma_w (1 - n); \quad \gamma_{dry} = \gamma_{wet} / (1 + W_c); \quad \gamma_{dry} = G \gamma_w / (1 + e); \quad \gamma_{sat} = (G + e) \gamma_w / (1 + e);$$

$$\gamma_{sat} = \gamma_{dry} + n \cdot \gamma_L; \quad n = \frac{W_c \cdot G}{1 + W_c \cdot G}; \quad n = V_v / V; \quad e = n / (1 - n); \quad \rho_g = \rho / (1 - n)$$

$$W_c = \frac{W_w}{W_s}; \quad S = \frac{V_w}{V_v}$$



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Typical Answers for Final Exam in Engineering Geology
1st Attempt 2014-2015

Q1. State whether each of the following statements is TRUE or FALSE and correct the FALSE one. (25Mark)

1. The triaxial compressive strength for determining clay shear strength is $\tau = \sigma_n \tan \Phi$.
F ($\tau = \sigma_n \tan \Phi + C$)
2. In shallow depths from earth surface, the horizontal stresses are smaller than the vertical stresses. F (the horizontal stresses are greater than the vertical stresses).
3. For the bulk density of rocks, the average must be used because the minerals may be present in different amounts. F (the weighted average must be used)
4. The driving force and the total friction force in the river become equal when the flow is at a constant velocity.
T
5. In river meanders, the abandoned bend is called an oxbow lake. T
6. The main variations causing variations in river velocity are gradient and shape of the river only. F (and degree of roughness of the surface on which water flows)
7. Seismic refraction and electrical resistivity methods geophysical methods to investigate the groundwater. T
8. The ground water exists in the zone of aeration. F (in the zone of saturation)
9. A rock with a high percentage of open spaces has high porosity. T
10. Water moves slowly through a clay stratum because the pores are not interconnected. F (the pore spaces are very small in size).

Q2. A. Fill the blanks with the suitable words. (15 Mark)

1. Depending upon the type of loading and the stresses, the strength may be classified as compressive strength, tensile strength and shear strength.
2. Rivers and streams transport their load of sediments in three ways dissolved load, suspended load and bed load.

Total precipitation = Evaporation + infiltration + Direct runoff.

4. Two types of discharges are presented in rivers; these are laminar flow and turbulent flow.
5. Ground water can be classified according to the total dissolved salts into four types Fresh water, Brackish water, Saline water and Brine water.

B. Choose the correct answer: (10 Mark)

1. A river's velocity is -----on the outside meander curve compared to the inside. a) higher b) equal c) lower
2. A platform of sediment formed where a stream flows into standing water is: a) an alluvial fan b) a delta c) a meander d) a flood plain
a) Porosity is: a) the percentage of a rock's volume that is openings; b) the capacity of a rock to transmit a fluid
c) the ability of a sediment to hold water; d) none of the preceding
3. The subsurface zone in which all rock openings are filled with water is called the: a) saturated zone b) water table c) unsaturated zone d) aquiclude
5. For most rocks, Poisson's ratio values are ranging between: a) 0.0-0.5 b) 0.0-0.4 c) 0.1-0.5 d) 0.2-0.3

Q3.A. A sandstone rock has a volume in its natural state of 0.0093 m^3 and weighs 177.6 N. The oven-dried weight of this rock is 153.63 N. If the specific gravity is 2.67.

- Calculate: 1. Moisture content (%) 2. Moist and dry unit weights
3. Void ratio and porosity 4. Degree of saturation

(16 Mark)

Solution

$$1) W = (W_{sat} - W_{dry}) / W_s = (177.6 \text{ N} - 153.63 \text{ N}) / 153.63 \text{ N} = 0.156 = (15.6\%)$$

$$2) \gamma_{wet} = \frac{W}{V} = \frac{177.6 \text{ N}}{0.0093 \text{ m}^3} = 19096.77 \text{ N/m}^3 = 19.1 \text{ kN/m}^3$$

$$\gamma_{dry} = \frac{\gamma_{wet}}{1 + W_c} = \frac{19.1 \text{ N}}{1 + 0.156} = 16.52 \text{ kN/m}^3$$

$$3) e = \frac{V_v}{V_s};$$

$$V_s = \frac{W}{\gamma_s} = \frac{W}{G \cdot \gamma_w} = \frac{0.15363 \text{ kN}}{2.67 \times 10 \text{ kN/m}^3} = 0.00575 \text{ m}^3$$

$$V_v = V - V_s = 0.0093 - 0.00575 = 0.00355 \text{ m}^3$$

$$e = \frac{V_v}{V_s} = \frac{0.00355 \text{ m}^3}{0.00575 \text{ m}^3} = 0.62$$

$$n = \frac{e}{1 + e} = \frac{0.62}{1 + 0.62} = 0.3827 = 38.3\%$$

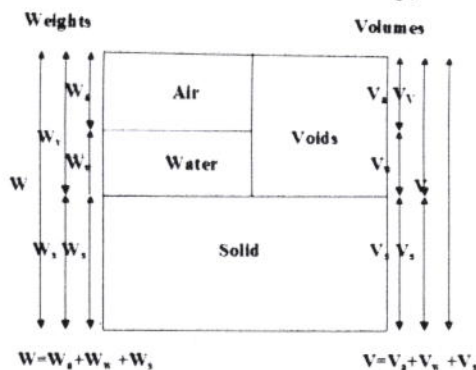
$$S = \frac{V_w}{V_v}$$

$$V_w = \frac{W_w}{\gamma_w} = \frac{W_{wet} - W_{dry}}{\gamma_w} = \frac{177.6 \text{ N} - 153.63 \text{ N}}{10000 \text{ N/m}^3} = \frac{23.97}{10000} = 0.002397 \text{ m}^3$$

$$S = \frac{V_w}{V_v} = \frac{0.0024 \text{ m}^3}{0.00355 \text{ m}^3} = 0.675 = 68\%$$

B. Show by sketches only the following items: (9 Mark)

1. The relation between rock constituents (Rock phase relationship).

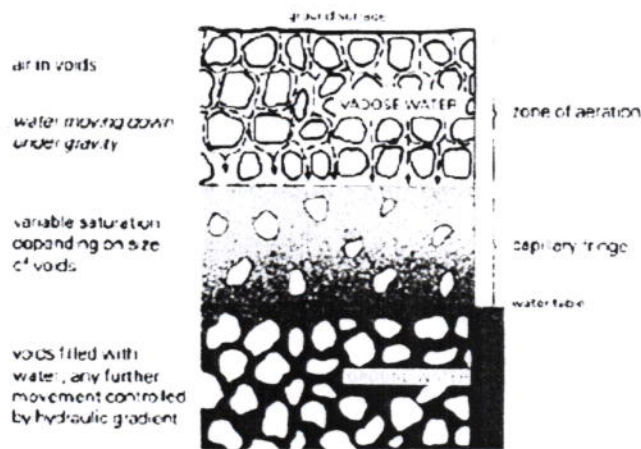


2. Vertical classification of groundwater.

1. Zone of aeration (unsaturated zone):

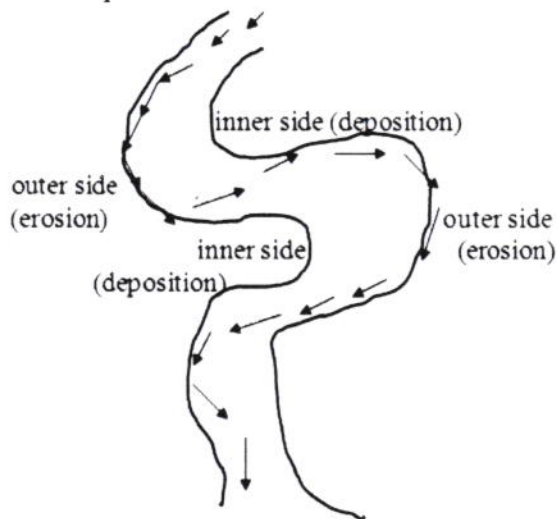
- Soil water zone (pellicular water):
- Gravitational water:
- Intermediate zone:
- Capillary zone:

2. Zone of saturation:



The distribution and behavior of water in rocks and soils in the subsurface.

3. A river meander showing its main parts.



River meanders.

Q4. A. An aquifer has a cross-section with a horizontal width of 265 m, and a vertical thickness below water table of 42 m. The water table is 36 m below ground surface. The discharge at this section is 3340 m³/d and the yield porosity 27.1%.

It is required to find:

- the aquifer cross-sectional area
- Darcy's velocity
- actual velocity of aquifer water

(15 Mark)

Solution

(a)

$$A = w \cdot h$$

$$A = (265 \text{ m}) \times (42 \text{ m}) = 1.113 \times 10^4 \text{ m}^2$$

(b)

$$Q = A \cdot v_D$$

$$0.03866 \text{ m}^3/\text{s} = (1.113 \times 10^4 \text{ m}^2) v_D$$

$$v_D = 3.47 \times 10^{-6} \text{ m/s}$$

(c) To calculate the actual velocity: Darcy's velocity v_D is converted to actual velocity by means of yield porosity (substituting with fraction)

$$v_D = n_y \cdot v$$

$$3.47 \times 10^{-6} \text{ m/s} = 0.271v$$

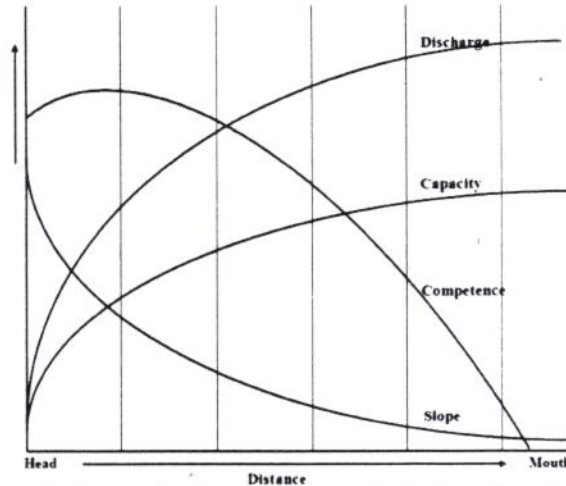
$$v = 1.28 \times 10^{-5} \text{ m/s}$$

$$v = 0.0128 \text{ mm/s}$$

This indicates that the groundwater flow can be very slow.

B. Answer the following items: (10 Mark)

1. Draw the general change in river characteristic from the head to mouth.

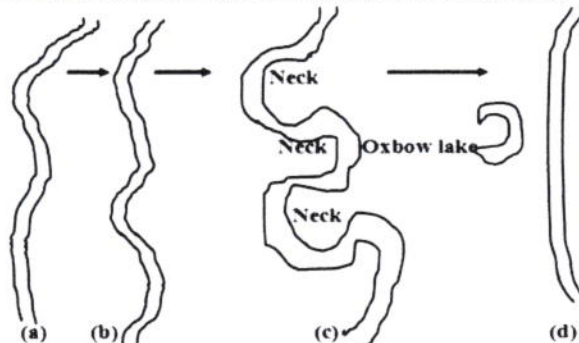


The general change in river characteristic from head to mouth.

2. List only the main index properties of rocks affecting design and construction in rocks.

1- Bulk density 2- Unit weight 3- Specific gravity 4- Porosity and void ratio 5- Dry and saturated unit weight 6- Moisture content 7- Degree of saturation

3. By sketches show the formation of a cutoff and oxbow lake in meanders.



Formation of a cutoff and oxbow lake.

Q5. A. A river with a width 120 m, depth 7 m, discharge $9065 \text{ m}^3/\text{s}$, gradient 0.002 and roughness coefficient 0.018. How long is the wetted perimeter, hydraulic radius and the river velocity? (15 mark)

Solution

$$Q = (1/n) A R^{2/3} S^{1/2}; \text{ Where } R^{2/3} = A^{2/3} / P^{2/3}$$

$$9065 \text{ m}^3/\text{s} = (1/0.018) * 840 \text{ m}^2 * [(120\text{m} * 7\text{m})^{2/3} / P^{2/3}] * (0.002)^{1/2}$$

$$9065 = (1/0.018) * 840 * (89.02 / P^{2/3}) * 0.044$$

$$P^{2/3} = 3290.18 / 163.17 = 20.164$$

$$P = 90.545 \text{ m}$$

$$R = A / P = (120\text{m} * 7\text{m}) / 90.545 = 9.277 \text{ m}$$

$$Q = V \cdot A$$

$$9065 \text{ m}^3 / \text{s} = V \cdot 840 \text{ m}^2$$

$$V = 10.79 \text{ m} / \text{s}$$

B. Answer Two of the following items: (10 Mark)

1. Prove that $e = n / (1 - n)$?

$$\begin{aligned} e &= V_v / V_s & ; & & V &= V_v + V_s & \text{ so } & & V_s &= V - V_v \\ e &= V_v / (V - V_v) & ; & \text{ and } & n &= V_v / V & \text{ so } & & V_v &= nV \\ e &= nV / (V - nV) = nV / V(1 - n) & & & & & \text{ so } & & e &= n / (1 - n) \end{aligned}$$

2. Define water table. What are the main characteristics of water table?

The water in the saturated zone is referred to as **groundwater**, and its upper surface is often referred to (not in strict usage of the term) as the **water table**.

The main characteristics of water table

1. It is the upper surface of groundwater. Its depth varies with local geological conditions and seasonal changes.
2. The water table is shaped like a subdued replica of the topography above it.
3. It is not static, as groundwater in a permeable rock is continually in motion. Highs in the water become flatter, and gradients are reduced, at a rate controlled mainly by the permeability of the rock. If an uncased well were drilled into the saturated zone, water would flow into it and, given time, fill it to a level which is a point on the water table, as precisely defined.
4. Definition of the water table and of its variation seasonally and over longer periods is important for groundwater supply and other practical purposes. It can be located and monitored by wells, and less accurately by **geophysical surveys** (such as electrical resistivity and seismic refraction techniques). In large investigations both would be used.
5. Natural discharge of groundwater takes place where the ground surface intersects the water table. If the flow from the hydrologic unit is spread diffusely over an area of marshy ground, it is usually referred to as seepage. If it is concentrated, say by a fissure acting as a channel, it is called a **spring**.

3. Differentiate between confined and unconfined aquifers.

The main characteristics of unconfined aquifers:

1. The unconfined aquifers are in direct contact with the atmosphere.
2. The water presented inside rocks are under the effect of atmospheric pressure alone, so these are called **free aquifers**.
3. The level of the water in these aquifers are affected by several factors such as topography of the area, amount of falling water in the region and the exhausted water from the wells.

The main characteristics of the confined aquifers are:

1. These aquifers are subjected to pressure higher than the atmospheric pressure as they are bounded by impermeable layers, both above and below the aquifer, must be present to prevent the water from escaping.
2. Water must be confined to an aquifer that is inclined so that one end is exposed at the surface where it can receive water that is called the **recharge area**.
3. When such aquifers are penetrated by wells, the rise and lowering of water inside these aquifers depend upon the variations resulted from pressure, amount of stored water which are different from that in the unconfined aquifers.

..... BEST WISHES.....

Useful Relations

$$\begin{aligned} \gamma_{dry} &= G \gamma_w (1 - n); & \gamma_{dry} &= \gamma_{wet} / (1 + W_c); & \gamma_{dry} &= G \gamma_w / (1 + e); & \gamma_{sat} &= (G + e) \gamma_w / (1 + e); \\ \gamma_{sat} &= \gamma_{dry} + n \cdot \gamma_L; & n &= \frac{W_c \cdot G}{1 + W_c \cdot G}; & n &= V_v / V; & e &= n / (1 - n); & \rho_g &= \rho / (1 - n) \\ W_c &= \frac{W_w}{W_s}; & S &= \frac{V_w}{V_v} \end{aligned}$$