Examination of Hydrogeology Module
Questions for Steady Groundwater Flow (given by Yangxiao Zhou)
Hydrology and Water Resources of WSE programme, 2013/2015
(Closed Book for 1 hour)

Question 1 (25%)

Confirm the following statements by circling the true or false:

(1) Groundwater flow can only reach steady state when total groundwater recharge is equal to total discharge.

     True ( )   False ( )

(2) Under the steady state flow in an infinite semi-confined aquifer, pumping rate from a well is equal to the amount of leakage.

     True ( )   False ( )

(3) Under the steady state, the groundwater heads will not change with time, therefore, groundwater flow must be zero.

     True ( )   False ( )

(4) A groundwater divide will be always established between two parallel canals in an unconfined aquifer with the uniform recharge.

     True ( )   False ( )

(5) In an isotropic aquifer, contour lines of groundwater heads are always perpendicular to the impermeable boundary and parallel to the constant head boundary.

     True ( )   False ( )

Question 2 (25%)

An aquifer is homogeneous, but anisotropic. The principle hydraulic conductivity K_x =10 m/day, K_y=5 m/day. The groundwater heads in three observation wells: A, B and C (Figure 1), were measured as150 m, 135 m and 125 m, respectively. The distances between observation wells A and B, A and C are same as 1000 m.
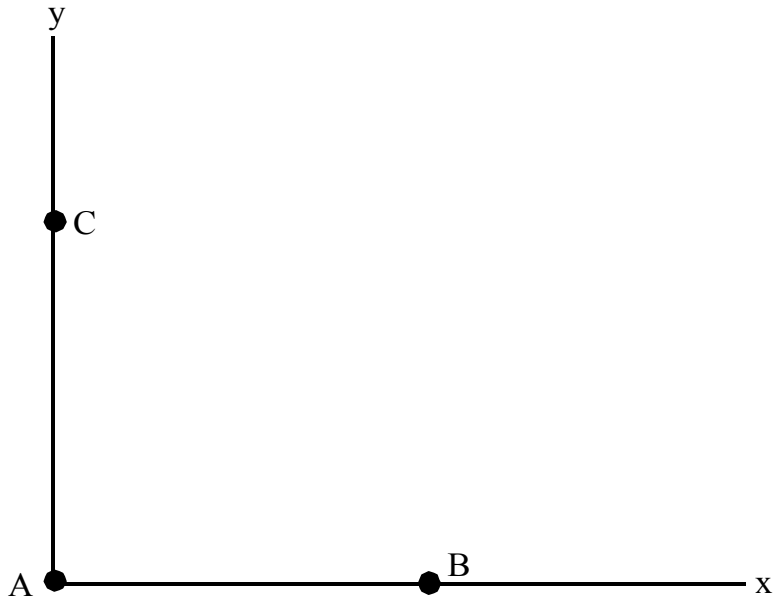

Figure 1 Locations of observation wells

(1)   Calculate specific discharges at observation well A in x and y directions, respectively.

(2)   Determine the groundwater flow direction (expressing in an angle from x-axis).

Question 3 (25%)

Two parallel drainage ditches were constructed to drain the excess water from a phreatic aquifer. Water levels in the two ditches were maintained at the same level as 19.0 m. The land surface elevation is 21 m. The hydraulic conductivity of the aquifer is 1.5 m/day and the uniform recharge to the aquifer is 1.5 mm/day. The general distribution of water table is described by:

$$h^2 = h_0^2 + \frac{wL}{K}x - \frac{w}{K}x^2 \qquad (1)$$

Please carry out the following tasks:

(1) Derive the formula to calculate the highest water table at the groundwater divide.

(2) If the highest water table has to be controlled 1.0 m below the land surface for maximum agricultural production, determine the distance between the two ditches.

(3) Calculate the drainage (water pump) capacity to maintain the required water level in the two ditches.

Question 4 (25%)

A pumping test was conducted in a confined aquifer with one pumping well and two observation wells. The measured steady state groundwater depths in 2 observation wells are given in Table 1. The pumping rate was 50 m^3/hour.

Table 1 Data from a pumping test

Observation well no.	Distance from pumping wells (m)	Elevation of wells (m)	Initial groundwater depth before pumping (m)	Steady state groundwater depth during the pumping test (m)
1	25.0	500	10	11.76
2	250.0	505	15	15.88
Pumping well	0.25 (Radius of the well)	500	10	

(1) Calculate drawdowns at two observation wells.
(2) Calculate the transmisivity value.
(3) Calculate the average radius of influence of the aquifer.

Note: the groundwater level is described by:

$$\varphi = \varphi_0 - \frac{Q_0}{2\pi T} \ln(\frac{R}{r}) \qquad (2)$$