**GEO2010 Spring 2016**

**Exercise 9**

Obligatory exercise 9 must be submitted by **…....**

**Training Exercise 9.1 - Rating curve measured at Bergheim in 2010 and 2011.**

NVE performs annual controls at their discharge gauging stations. The control consists of three parts: levelling, discharge measurement and flushing the cistern between the river and the stilling well. GEO2010 was involved in the discharge measurement and got the following results:

The discharge was measured at 189.3 m3/ s in 2010 and 56 m3/ s in 2011.

The stage (water level) was measured at 152.47 meters above sea level in 2010 and 151.64 m in 2011.

I) Describe and justify the location requirements of the measurement site for discharge measurements.

ii) Discuss sources of uncertainty when determining extremely small and extremely large discharges.

The aim of this exercise is to plot one point on the rating curve of Bergheim. First you need to plot the rating curve, which is given by

Q = aHb (Q plotted on the x axis, H on the y axis).

Parameters by Bergheim: a = 30.7223

H = water level- 150.3 (H is the local height)

b = 2.386

iii) Plot the rating curve with height on the y axis.

Then, plot the one point we measured: stage (water level) (m) against the discharge (m3/ s). Does the measurement fit the rating curve?

**Theory:**

A rating curve is a relationship between discharge and water stage. When the water stage is high, the discharge is high. When the water stage is 0, the discharge is 0. Therefore, the rating curve starts at the point (0,0).

The rating curve is made by measuring water flow and water stages at the same point in time. This happens maybe once a year, so it takes a long time to accumulate many points to the curve. When the curve has some points (more than 3, and preferably more than 10) a curve fitted to the points is made. This curve is given by the formula Q = aHb. Therefore, the rating curve at Bergheim will not be handed out, but you have to draw it yourself by choosing H-values and calculate the Q-values of the selected H values.

When the curve is drawn you have to plot the discharge and water stages that we measured, at one point. Then you need to check whether this point fits the curve.

Next problem is the water stage, which can be expressed in absolute height (altitude). We are interested in local water stages. To find this you must subtract the levelling point from the water stages. You have to subtract this number from all the measurements of local water stages before plotting. The rating curve always begins at (0,0).

**Training Exercise 9.2 - Calculate flow with salt measuring method.**

The exercise text this week is given as an excursion guide *(Worksheet 10.PDF)* to a measurement of discharge using the salt dilution method We are going to make a corresponding measurement on excursion in May. The data in *Oppgave\_10\_data.xls* is from a measurement in Gaustadbekken in spring 2008.

The aim of the test is to estimate the discharge in a small, turbulent stream by measuring the concentration of salt about 100 meters downstream, before and after we added a saline. The concentration of salt can be found by measuring the electrical conductivity of water with an electrolyte. The conductivity is proportional to the salt concentration, so the concentration is calculated from the conductivity data.

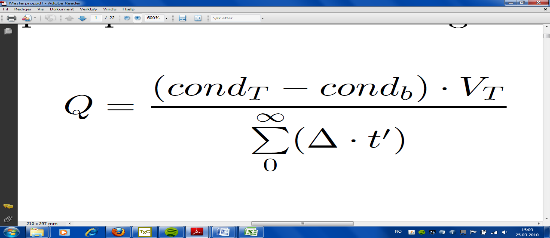
First, we measured the background conductivity in Gaustadbekken, *condb,* = 74 μS / cm.

We added 2.8 kg salt to 25 liters of water, so the water got a conductivity *cond* = 84 000 μS / cm. We ignored the increase in water volume as a result of the added salt.

The water temperature was 4.2 ° C.

All the salt was added at the same time (gulp injection), and two students measured the conductivity 100 meters downstream (see excel sheet). First, it was taken a measurement every 5 seconds, and after 11 measurements, every 10 seconds until the conductivity was back to the starting conductivity.

The discharge was then calculated using the formula



What is the discharge in m3/ s, and what is the in l / s?

**Obligatory exercise – Linear-Reservoir Model**

Use linear-reservoir model (Dingman box 2-9) to calculate the discharge in response to these input

W = 1 unit / hour Duration of five hours

T \* = 1 hour

a) What type of input we are talking about here? What is the common unit for W?

b) Plot the first twenty hours in Excel with half-hour resolution (calculate discharge for every half hour). Is twenty hours enough to describe the whole event?

c) Do the same calculation, but with

W = 1 unit / hour Duration of five hours

T \* = 2 hours

Plot this in the same diagram as for the calculation of T \* = 1 hour (half-hour resolution). How can one interpret T \*?

d) Try with different W, to see how the discharge in the linear-reservoir model responds to different parameters. Choose three values of W (justify the choice) and show three figures with two curves each (T \* = 1 and T \* = 2). Comment your findings.

e) Determine the time when discharge as a response to the input ends in part a) T \* = 1.

f) What is the linear-reservoir model used for?