**Home-work 2: Production profiles for any minable resource**

You will submit one .xlsx file with seven sheets. The first six of these will be for computing and plotting time-profiles of six distinct models for the production of any minable resource. Each sheet will have only one model in it. It will contain all the relevant data as well as plots of the corresponding model.

Each model is a way to construct a production profile for future production of a minable resource based on certain assumptions. The cumulative above ground resource mined is A(t) at time t. The cumulative resource left below ground at time t is B(t). Each model has $B_0$ units below ground initially and $A_0$ units above ground initially.

Detailed instructions on making the spread-sheet and plots are provided below. Instructions 1 – 16 below are to be implemented for all six models. The equations for various models are given in instruction 17. Instruction 17 and 18 also involve comparing and observing relationships between various models. This may be done on the seventh sheet in the file.

The final completed file will be submitted to sanjay.khare@utoledo.edu by each team by 5 pm on 12th February 2016.

Derivative Models – Tutorial

1. Set a cell in your spread sheet for initial reserves above the ground, $A_0$ equal to 0.1.

   $A_0 = 0.1$

2. Set a cell for initial reserves below the ground, $B_0$ equal to 2000.

   $B_0 = 2000$

3. Set one cell for the constant, k and equate it to the corresponding value mentioned below, according to the model.

4. Set one cell for the time difference, $\Delta t$ equal to 0.1.

   $\Delta t = 0.1$

5. Set the first column for t and initialize its first value to 0.

   Calculate the other values for t using the formula, $t_{i+1} = t_i + \Delta t$,

   where i is the number of the row, i = 1, 2, 3…..

6. Set the second column for A(t) and equate the first value to $A_0$.

7. Set the third column for B(t) and equate the first value to $B_0$.

8. Set the fourth column for $\Delta A$ and equate it according to the equation for the corresponding model.

9. Set the fifth column for $\Delta B$ to calculate the change in B(t).

10. Set the sixth and seventh columns for $\Delta A/\Delta t$ and $\Delta B/\Delta t$ respectively.

11. Calculate the other values for A(t) using the formula, $A_{i+1} = A_i + \Delta A$,

    where i is the number of the row.

12. Calculate the other values for B(t) using the formula, $B_i = A_0 + B_0 – A_{i,}$

    where i is the number of the row.

13. Calculate the other values for $\Delta B$ using the formula, $\Delta B = B_{i+1} - B_i$,

    where i is the number of the row.

14. Calculate the corresponding values for $\Delta A/\Delta t$ and $\Delta B/\Delta t$.

15. Stop your process when $\Delta A < 0$. For certain models it will not go to zero ever. In such cases find the area under the curve of A(t) versus t. Make a column for the area under the curve. When it reaches a certain value you should stop computing the columns further. Write down this certain value. You will have to think about what this value should be.

16. Make separate plots for A(t), B(t), $\Delta A/\Delta t$ and $\Delta B/\Delta t$ with time.

17. Interpret and comment on your results for the four 1, 2.1, 2.2 and 2.3 models:

    (i) the numerical result in each column and also (ii) the plot.

    How are models 1, 2.1, 2.2 and 2.3 related to each other?

    Use the following equations and values for k for these four models.

    Model-1: $\Delta A = k (\Delta t)$, k = 200

    Model-2.1: $\Delta A = k A(t)B(t) (\Delta t)$, $k = 9.92 \times 10^{-04}$

    Model-2.2: $\Delta A = k A(t)B(t) (\Delta t)$, $k = 4.96 \times 10^{-04}$

    Model-2.3: $\Delta A = k A(t)B(t) (\Delta t)$, $k = 2.48 \times 10^{-04}$

    Model-3: $\Delta A = k A(t) (\Delta t)$, k = 0.36

    Model-4: $\Delta A = k B(t) (\Delta t)$, k = 0.36

18. Interpret and comment on your results for all the remaining models:

(i) The numerical result in each column and also (ii) the plot.

How are models 1, 3 and 4 related to model 2?