This is HW 2 due on 19[th] February 2014 by 5:00 p.m. in the email box of Mr. Vamshidhar Rao, VamshidharRao.Boinapally@rockets.utoledo.edu. Do not send it to Prof. Khare.

You will submit one excel file with four sheets corresponding to four different models for the production of any minable resource. Each sheet should have 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_o units below ground initially and A_o units above ground initially. Detailed instructions on making the spread-sheet and plots are provided below.

Derivative Models – Tutorial

1. Set a column for initial reserves above the ground, A_o equal to zero.

   $A_0 = 0.1$

2. Set a column for initial reserves below the ground, B_o equal to 2000.

   $B_0 = 2000$

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

4. Set a column for the time difference, Δt equal to 1.

   $\Delta t = 1$

5. Set a 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 a column for A(t) and equate the first value to A_0.

7. Set a column for ΔA and equate it according to the equation for the corresponding model.

8. Set a column for $\Delta A/\Delta t$.

9. Set a column for B(t) and equate the first value to B_0.

10. Set a column for $\Delta B/\Delta t$ to calculate the change in B(t).

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 ΔB using the formula, $\Delta B = B_{i+1} - B_i$,

 where i is the number of the row.

14. Calculate the corresponding values for ΔA/Δt and ΔB/Δt.

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.

16. Make separate plots for

 i. A(t), B(t) ;
 ii. ΔA/Δt, ΔB/Δt with time.

17. Interpret and comment on your results for all four models:

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

 How are models 1-3 related to model 4, if at all? What are the differential equations you would solve for each of these models. Solve them and compare your solution with what you find in your numerical solution. Is it consistent with what you find?

18. Check that they are consistent with each other.

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

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

 Model-2: $\Delta A = k A (\Delta t)$, $k = 0.36$

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

 Model-4: $\Delta A = kAB(\Delta t)$, $k = 3.0 \times 10^{-4}$