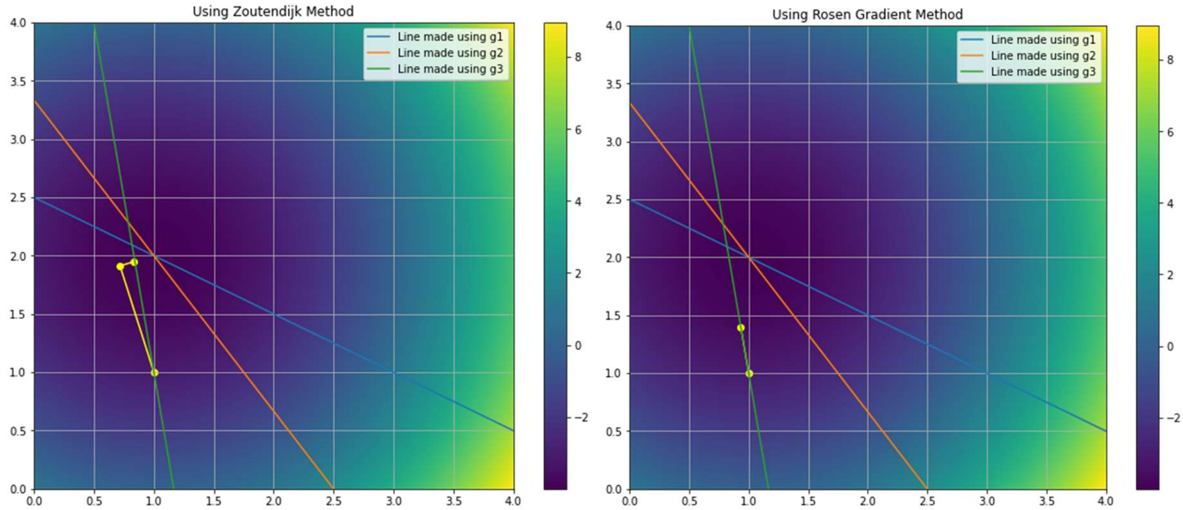
ME7223: ASSIGNMENT 7

SAARTHAK SANDIP MARATHE | ME17B162

Question 1:

The two different methods were applied and their graphs are as shown below:

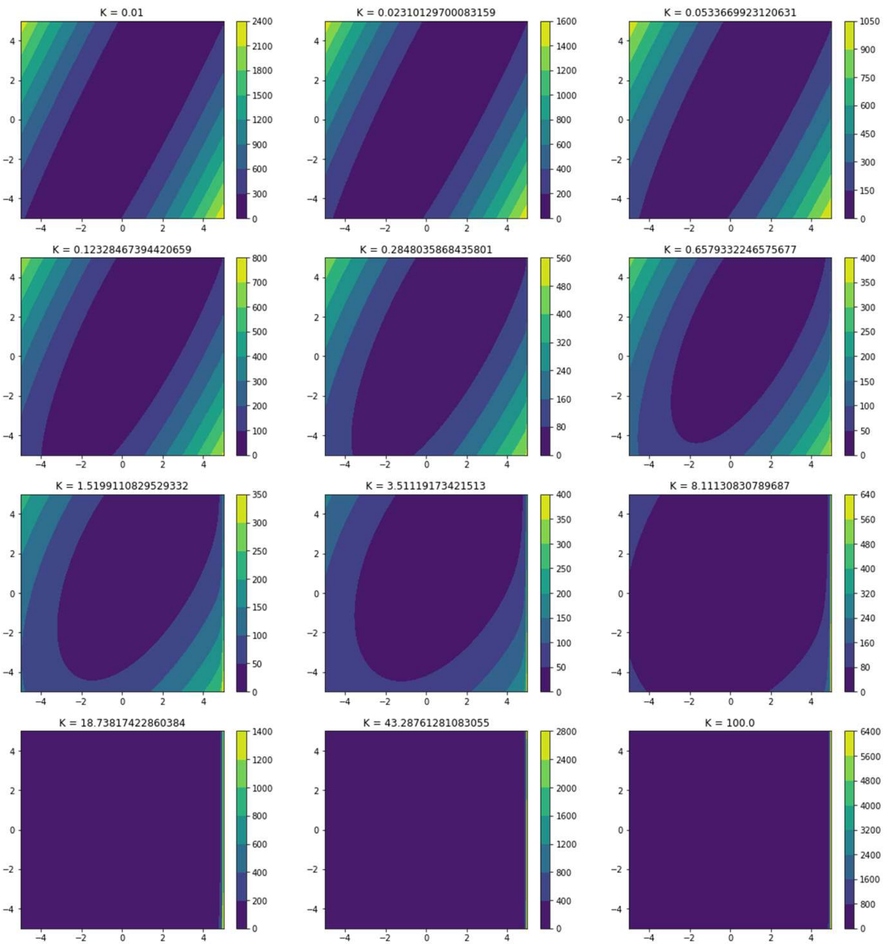


From this we can see that, the Rosen Gradient Method follows the green (g3) line.

The one step of Rosen Gradient Method is farther away from the first step of Zoutendijk method

Rosen Gradient Method is known to take a lot of time to reach the optimum. More no of iterations than what Zoutendijk would take.

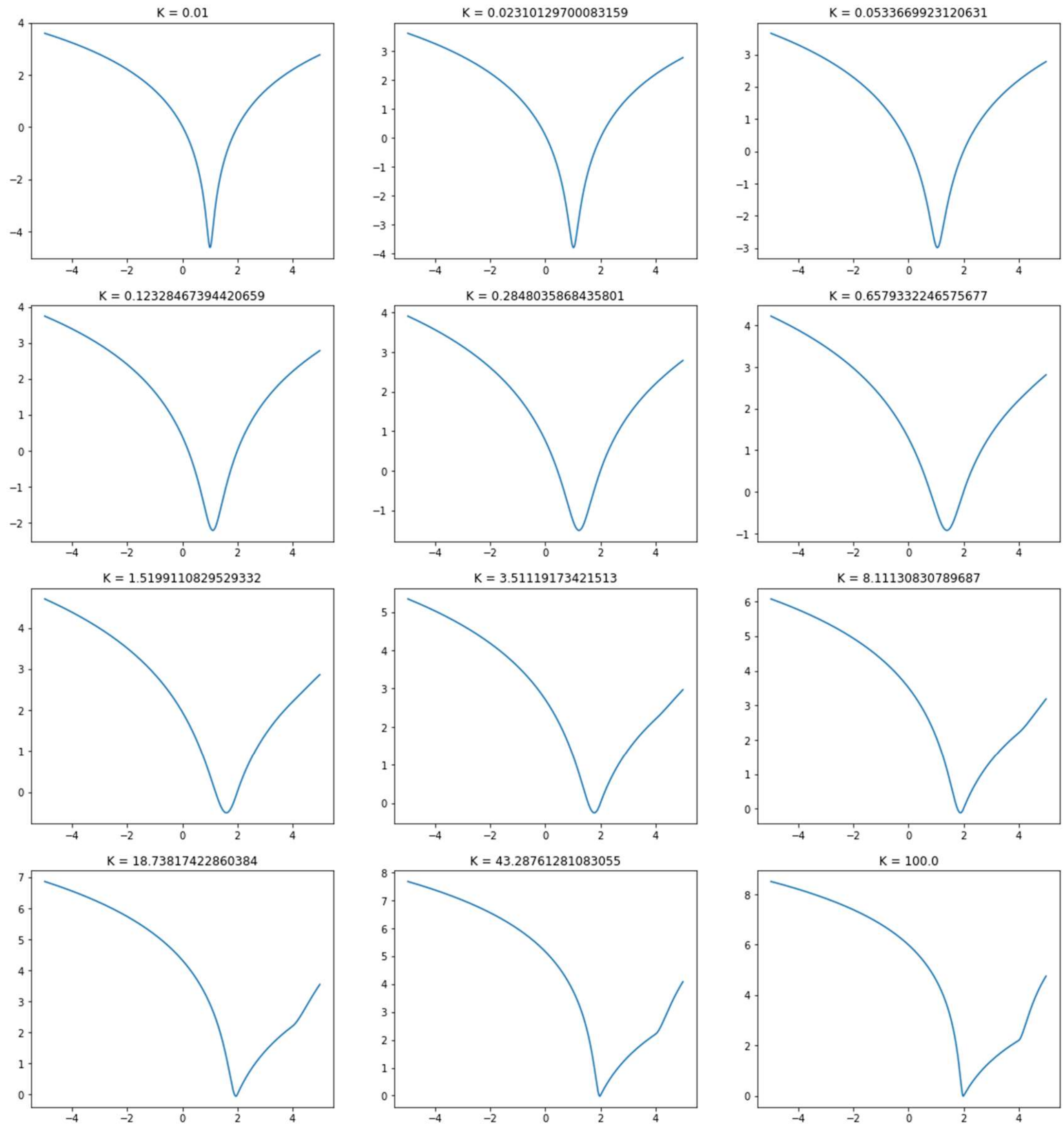
Question 2:



- The above graph shows the Interior penalty function contour values. (rk in general formula is taken as k here)
- For this question, we had taken k initial to be 0.01 as we can see that at k=0.01 the contours and the minima point is more distinct and thus we start the decay of k values with 0.8 as the factor.
- With 2e-5 taken as tolerance and [1,3] as initial values, we finally reach the optimum value after 17 iterations with:
  Coordinate: [0.99999629 1.99999261] - Objective Function: 6.836980396047215e-11
  K value: 0.00022517998136852504
- These are the optimum variable values that we get using the interior penalty function method

Question 3:

For this, we apply the exterior penalty function. While plotting the simple ext_penalty(x) vs x graph, we saw that almost all graphs were same plots so a semilog graph was plotted as shown below:



- rk in general formula is taken as k here. We choose k=100 as the starting initial value as it gives the steepest slope near the minimal value of external penalty function.
- We take the k_amp value as 5. With tolerance as 2e-5 and x=3 as initial value, we finally reach:
  Coordinate: [2.] - Objective Function: [0.99999999] as the solution in 10 iterations

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ME17B162

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4) $f(x_1, x_2) = \left(9 - (x_1 - 3)^2\right) \cdot \frac{x_2^3}{27\sqrt{4}}$

$x_1 \geq 0 \rightarrow ①$

$0 \leq x_2 \leq \frac{x_1}{\sqrt{3}} \rightarrow ②$

$0 \leq x_1 + \sqrt{3}\, x_2 \leq 6 \rightarrow ③$

we can take $x_1 = 3\sin^2 y_1$. This will help simplify the obj function.

from ②, ③

$\therefore 0 \leq x_2 \leq \sqrt{3}\sin^2 y_1$

$0 \leq 3\sin^2 y_1 + \sqrt{3}\, x_2 \leq 6$

we can here write, x_2 as a $f(\sin^2 y_1, y_2)$ where y_2 is another variable.

$\therefore$ x_2 can be $= \sqrt{3}\sin^2 y_1 \cdot \sin^2 y_2$

which makes ②, ③ :

$0 \leq \sqrt{3}\sin^2 y_1 \cdot \sin^2 y_2 \leq \sqrt{3}\sin^2 y_1 \rightarrow ②$

$0 \leq 3\sin^2 y_1 (1 + \sin^2 y_2) \leq 6 \rightarrow ③$

These two conditions are satisfied as, $0 \leq \sin^2 y_2 \leq 1$ and ~~which~~ with ③ we can write :

$3\sin^2 y_1 (1 + \sin^2 y_2) \leq 3\sin^2 y_1 (1+1) = 6\sin^2 y_1$

$\Rightarrow ③ \Rightarrow 0 \leq 6\sin^2 y_1 \leq 6 \Rightarrow 0 \leq \sin^2 y_1 \leq 1$ which is still satisfied

The transformation made will be :

$f(y_1, y_2) = 9(1 - \cos^4 y_1) \cdot \frac{3\sqrt{3}}{27\sqrt{4}} \cdot \sin^6 y_1 \cdot \sin^6 y_2$

$\therefore f(y_1, y_2) = \sqrt{\frac{3}{4}} (1 - \cos^4 y_1) \cdot \sin^6 y_1 \cdot \sin^6 y_2$

$f(y_1, y_2) = \frac{\sqrt{3}}{2} (1 + \cos^2 y_1) \cdot \sin^8 y_1 \cdot \sin^6 y_2$ $\Rightarrow$ can be solved in unconstrained fashion