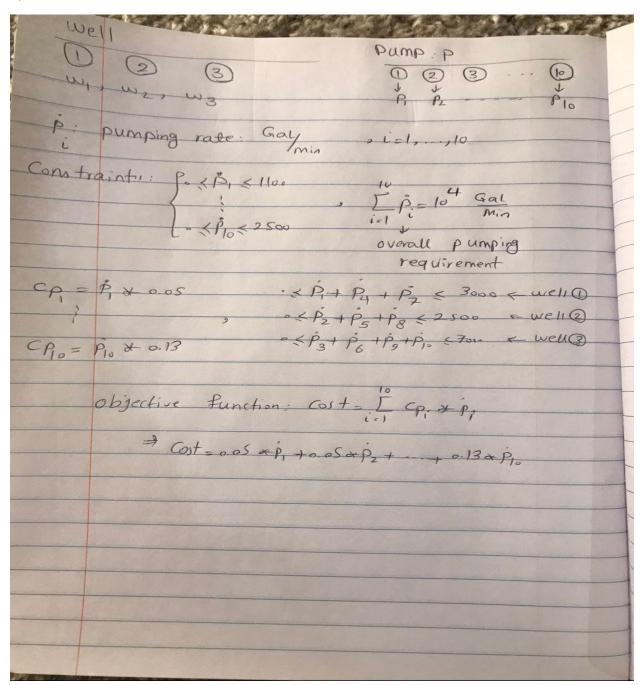
Homework 9:

Sanaz Salari

Q1:



GAMS Code:



^{*} Lancaster's water distribution system: This is a LP

```
Set pump / 1*10 /;
alias(pump,j);
parameter c(j) 'costs of operating each pump'
     /1 0.05, 2 0.05, 3 0.05, 4 0.07, 5 0.07, 6 0.07, 7 0.13, 8 0.13, 9 0.13, 10 0.13/;
*positive variables x(j) 'x(j)= pump rate per minute of pump j, j=1,...,10';
positive variables x(j) 'x(j) is pump rate of pump j';
variable cost;
equations
     Con1,
     Con2,
     Con3,
     Con4,
     Con5,
     Con6,
     Con7,
     Con8,
     Con9,
     Con10,
     Con11,
     Con12,
     Con13,
     Con14,
     Obj
Con1 .. x('1') + x('4') + x('7') = 1 = 3000;
Con2 .. x('2') + x('5') + x('8') = l=2500;
Con3 .. x('3') + x('6') + x('10') = I = 7000;
```

```
Con4 .. x('1') = |=1100;

Con5 .. x('2') = |=1100;

Con6 .. x('3') = |=1100;

Con7 .. x('4') = |=1500;

Con8 .. x('5') = |=1500;

Con9 .. x('6') = |=1500;

Con10 .. x('7') = |=2500;

Con11 .. x('8') = |=2500;

Con12 .. x('9') = |=2500;

Con13 .. x('10') = |=2500;

Con14 .. sum(j, x(j)) = e=10000;

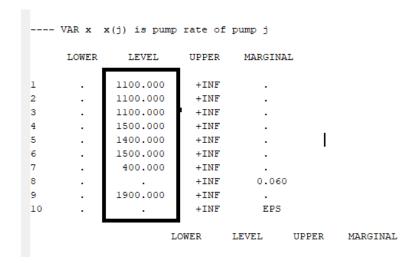
Obj .. cost = e= sum(j, c(j) * x(j));

model m1 /all/;
```

solve m1 minimizing cost using LP;

2:

xj (j=1,2,...,10) values are as follows:



And cost value is:

```
LOWER LEVEL UPPER MARGINAL
---- VAR cost -INF 772.000 +INF .
```

Q2:

1.

	APPL	GOLD	SBUX	F	
Proportion	0.42	0	0.41	0.17	

(Note: the proportion values must sum up to 1.)

What is the optimal standard deviation value? _____0.025_____

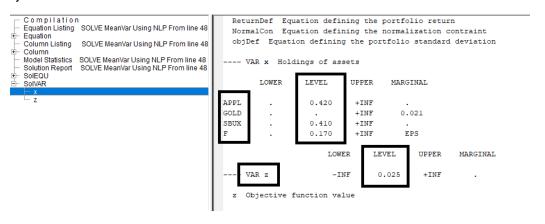
the screenshots of the GAMS model:

```
$TITLE Mean-variance model.
 * MeanVar.gms: Mean-Variance model.
 * Consiglio, Nielsen and Zenios.
 * PRACTICAL FINANCIAL OPTIMIZATION: A Library of GAMS Models, Section 3.2
 * Last modified: Apr 2008.
 SET Assets /APPL, GOLD, SBUX, F/;
 ALIAS (Assets, i, j);
 PARAMETERS
         ExpectedReturns(i) Expected returns /APPL 0.0480625, GOLD -0.0238125, SBUX 0.0220625, F 0.0045000 /;
 table
         VarCov(i,j)
                           GOLD
                                        SBUX
             APPL
APPL 2.471529e-03 -0.0010721458 1.241958e-04 -1.396667e-05
GOLD -1.072146e-03 0.0016157625 7.590542e-04 1.618333e-04
SBUX 1.241958e-04 0.0007590542 9.847292e-04 1.203333e-05
    -1.396667e-05 0.0001618333 1.203333e-05 2.010667e-04
POSITIVE VARIABLES
   x(i) Holdings of assets;
VARIABLES
               Objective function value
   z
*x(i) is a portfolio vector
```

```
*x(i) is a portfolio vector
EQUATIONS
                Equation defining the portfolio return,
    ReturnDef
   NormalCon
               Equation defining the normalization contraint,
    objDef
                Equation defining the portfolio standard deviation
ReturnDef ..
               SUM(i, ExpectedReturns(i)*x(i)) =g= 0.03;
NormalCon ..
               SUM(i, x(i)) = e= 1;
ObjDef
                             =e= sqrt(SUM((i,j), x(i)*VarCov(i,j)*x(j)));
MODEL MeanVar 'PFO Model 3.2.3' /ReturnDef,NormalCon,ObjDef/;
solve MeanVar min z using NLP;
```

the solution listing file:

xj and z values are as follows:



2.

Mean return rate	0.005	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05
Risk (SD of return rate)	0.013	0.013	0.014	0.017	0.021	0.025	0.030	0.036	0.044	0.050

a. All instances are feasible except the last one. This is because by putting xj values in return definition formula, the result is 0.0480625 which should be 0.05:

ReturnDef .. SUM(i, ExpectedReturns(i)*x(i)) =e= 0.05;

b. As we see in the following plot, for larger values of mean return rate, the risk of the optimal investments generated become higher.

