



Entraînement - Training

INSTRUCTION : English version below

En haut de chaque page se trouvent 3 nombres, par exemple +1/3/58+. Vous **devez** vérifier que, sur chacune des pages de votre sujet, le **premier** de ces 3 nombres est le même (dans cet exemple, il s'agit donc du 1). Ce nombre identifie votre copie. Les deux autres nombres ne sont pas importants.

Détacher la dernière feuille et répondre dessus. Ne pas rendre les pages contenant les questions, vous ne devez rendre **que la dernière feuille**. Chaque question est sur 1 point, aucun point ne sera attribué aux questions contenant une mauvaise réponse.

Les questions faisant apparaître le symbole ♣ peuvent présenter une ou plusieurs bonnes réponses qui doivent toutes être cochées. Les autres ont une unique bonne réponse.

At the top of each page are written 3 numbers, +1/3/58+. You **must** check that, on each page you have, the **first** number is the same (in this case, it would be the number 1). This number is the id of your subject. The two other numbers are not important.

Answer only on the last page. Keep the other pages containing the questions, you just have to return **the last page**. Each right answer gives you 1 point. For any wrong answer, the mark of the question is 0.

If there is a question with a symbol ♣, there may be one or more right answer. All of them must be checked. Any other question has only one right answer.

Question 1

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 0 \\ 2 \\ 8 \\ 0 \end{pmatrix}$; with the basis $B = (2, 3)$.

$$\nabla f(x) = \begin{pmatrix} -3 \\ 10 \\ -8 \\ -5 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} -1 & 1 \\ -1 & -1 \end{pmatrix}, A_N = \begin{pmatrix} -1 & 0 \\ -1 & -1 \end{pmatrix}$$

Comput the direction d followed by the algorithm during that iteration.

1	$\begin{pmatrix} -3 \\ 17 \\ 21 \\ 6 \end{pmatrix}$	3	$\begin{pmatrix} 6 \\ 8 \\ 12 \\ -15 \end{pmatrix}$	5	$\begin{pmatrix} 19 \\ 12 \\ -23 \\ 27 \end{pmatrix}$	7	$\begin{pmatrix} -3 \\ -5 \\ -5 \\ 6 \end{pmatrix}$	■	$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$
2	$\begin{pmatrix} -3 \\ 20 \\ 15 \\ 6 \end{pmatrix}$	4	$\begin{pmatrix} 19 \\ -30 \\ -12 \\ 27 \end{pmatrix}$	6	$\begin{pmatrix} 19 \\ 21 \\ 19 \\ 27 \end{pmatrix}$	8	$\begin{pmatrix} 6 \\ -9 \\ -21 \\ -15 \end{pmatrix}$	10	$\begin{pmatrix} 6 \\ -20 \\ 20 \\ -15 \end{pmatrix}$



Question 2

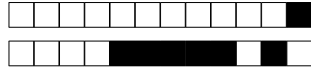
We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 4 \\ 0 \\ 4 \\ 0 \end{pmatrix}$; with the basis $B = (1, 3)$.

$$\nabla f(x) = \begin{pmatrix} -5 \\ -10 \\ 3 \\ 8 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} -1 & -2 \\ -2 & -1 \end{pmatrix}, A_N = \begin{pmatrix} 1 & -2 \\ -1 & 1 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

1 $\begin{pmatrix} -16 \\ -13 \\ -18 \\ -5 \end{pmatrix}$	3 $\begin{pmatrix} -12 \\ 2 \\ -30 \\ 1 \end{pmatrix}$	5 $\begin{pmatrix} -7 \\ -13 \\ 16 \\ -5 \end{pmatrix}$	7 $\begin{pmatrix} 2 \\ 2 \\ -9 \\ 1 \end{pmatrix}$	9 $\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$
2 $\begin{pmatrix} 3 \\ 11 \\ 6 \\ -19 \end{pmatrix}$	 $\begin{pmatrix} -2 \\ 2 \\ -1 \\ 1 \end{pmatrix}$	6 $\begin{pmatrix} 5 \\ 11 \\ -2 \\ -19 \end{pmatrix}$	8 $\begin{pmatrix} 0 \\ -13 \\ 5 \\ -5 \end{pmatrix}$	10 $\begin{pmatrix} -22 \\ 11 \\ 11 \\ -19 \end{pmatrix}$



Question 3

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 3 \\ 4 \\ 0 \\ 0 \end{pmatrix}$; with the basis $B = (1, 2)$.

$$\nabla f(x) = \begin{pmatrix} 8 \\ 4 \\ 8 \\ -1 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} -2 & 1 \\ -2 & -2 \end{pmatrix}, A_N = \begin{pmatrix} 1 & 2 \\ 2 & -2 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

1 $\begin{pmatrix} 26 \\ 11 \\ 10 \\ 13 \end{pmatrix}$	$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	5 $\begin{pmatrix} -27 \\ -23 \\ -1 \\ -20 \end{pmatrix}$	7 $\begin{pmatrix} -26 \\ 12 \\ -1 \\ -20 \end{pmatrix}$	9 $\begin{pmatrix} 28 \\ -3 \\ -20 \\ 28 \end{pmatrix}$
2 $\begin{pmatrix} -13 \\ 17 \\ -20 \\ 28 \end{pmatrix}$	4 $\begin{pmatrix} -5 \\ -11 \\ -1 \\ -20 \end{pmatrix}$	6 $\begin{pmatrix} 17 \\ 17 \\ -20 \\ 28 \end{pmatrix}$	8 $\begin{pmatrix} -24 \\ -11 \\ 10 \\ 13 \end{pmatrix}$	10 $\begin{pmatrix} 22 \\ -20 \\ 10 \\ 13 \end{pmatrix}$



Question 4

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 0 \\ 0 \\ 10 \\ 0 \end{pmatrix}$; with the basis $B = (3, 4)$.

$$\nabla f(x) = \begin{pmatrix} -5 \\ 1 \\ 6 \\ -6 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} 0 & 2 \\ -2 & 0 \end{pmatrix}, A_N = \begin{pmatrix} 0 & -2 \\ -1 & 1 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

$\boxed{1} \begin{pmatrix} -20 \\ -20 \\ -4 \\ 22 \end{pmatrix}$	$\boxed{3} \begin{pmatrix} -26 \\ -12 \\ -25 \\ -16 \end{pmatrix}$	$\boxed{5} \begin{pmatrix} -20 \\ -20 \\ -30 \\ -12 \end{pmatrix}$	$\boxed{7} \begin{pmatrix} -26 \\ -12 \\ -6 \\ 29 \end{pmatrix}$	$\blacksquare \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$
$\boxed{2} \begin{pmatrix} 4 \\ -27 \\ -21 \\ 13 \end{pmatrix}$	$\boxed{4} \begin{pmatrix} 4 \\ -27 \\ -26 \\ -9 \end{pmatrix}$	$\boxed{6} \begin{pmatrix} 4 \\ -27 \\ -30 \\ 23 \end{pmatrix}$	$\boxed{8} \begin{pmatrix} -26 \\ -12 \\ 29 \\ 2 \end{pmatrix}$	$\boxed{10} \begin{pmatrix} -20 \\ -20 \\ -30 \\ -25 \end{pmatrix}$



Question 5

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 10 \\ 4 \\ 8 \\ 0 \end{pmatrix}$; with the basis $B = (2, 3)$.

$$\nabla f(x) = \begin{pmatrix} 7 \\ 4 \\ -4 \\ 9 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}, A_N = \begin{pmatrix} 1 & -2 \\ -2 & -2 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

$\boxed{1} \begin{pmatrix} 19 \\ 28 \\ -4 \\ -3 \end{pmatrix}$	$\boxed{3} \begin{pmatrix} 11 \\ -2 \\ 26 \\ -30 \end{pmatrix}$	$\boxed{5} \begin{pmatrix} 5 \\ -28 \\ 5 \\ 0 \end{pmatrix}$	$\boxed{7} \begin{pmatrix} 19 \\ -7 \\ -18 \\ -3 \end{pmatrix}$	$\boxed{9} \begin{pmatrix} 5 \\ 29 \\ -11 \\ 0 \end{pmatrix}$
$\boxed{2} \begin{pmatrix} 11 \\ 13 \\ 6 \\ -30 \end{pmatrix}$	$\boxed{4} \begin{pmatrix} 11 \\ 16 \\ -25 \\ -30 \end{pmatrix}$	$\boxed{6} \begin{pmatrix} 19 \\ -14 \\ -8 \\ -3 \end{pmatrix}$	$\boxed{8} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	$\blacksquare \begin{pmatrix} 5 \\ 0 \\ 15 \\ 0 \end{pmatrix}$



Question 6

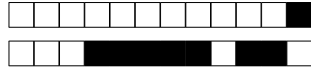
We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 3 \\ 9 \\ 0 \\ 0 \end{pmatrix}$; with the basis $B = (1, 2)$.

$$\nabla f(x) = \begin{pmatrix} -3 \\ 0 \\ 2 \\ 10 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} 1 & 2 \\ -1 & 0 \end{pmatrix}, A_N = \begin{pmatrix} 0 & -1 \\ 2 & -2 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

$\boxed{1} \begin{pmatrix} 1 \\ 8 \\ 10 \\ -14 \end{pmatrix}$	$\boxed{3} \begin{pmatrix} 22 \\ 25 \\ -26 \\ 4 \end{pmatrix}$	$\boxed{5} \begin{pmatrix} -17 \\ 0 \\ -26 \\ 4 \end{pmatrix}$	$\boxed{7} \begin{pmatrix} 18 \\ -12 \\ 10 \\ -14 \end{pmatrix}$	$\boxed{9} \begin{pmatrix} -24 \\ 8 \\ 0 \\ 5 \end{pmatrix}$
$\boxed{2} \begin{pmatrix} -24 \\ 19 \\ 0 \\ 5 \end{pmatrix}$	$\boxed{4} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	$\boxed{6} \begin{pmatrix} -18 \\ -23 \\ -26 \\ 4 \end{pmatrix}$	$\boxed{8} \begin{pmatrix} 16 \\ -20 \\ 10 \\ -14 \end{pmatrix}$	$\blacksquare \begin{pmatrix} 25 \\ -5 \\ 0 \\ 5 \end{pmatrix}$



Question 7

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 0 \\ 3 \\ 0 \\ 0 \end{pmatrix}$; with the basis $B = (1, 2)$.

$$\nabla f(x) = \begin{pmatrix} -10 \\ 9 \\ 9 \\ -1 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} -1 & -2 \\ 0 & -2 \end{pmatrix}, A_N = \begin{pmatrix} -2 & 0 \\ 1 & -1 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

[1] $\begin{pmatrix} -21 \\ -6 \\ -5 \\ 3 \end{pmatrix}$	[3] $\begin{pmatrix} 21 \\ -3 \\ 14 \\ -15 \end{pmatrix}$	[5] $\begin{pmatrix} -12 \\ 4 \\ -5 \\ 3 \end{pmatrix}$	[7] $\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	[9] $\begin{pmatrix} 1 \\ 14 \\ 25 \\ -8 \end{pmatrix}$
[2] $\begin{pmatrix} -19 \\ -29 \\ 25 \\ -8 \end{pmatrix}$	[4] $\begin{pmatrix} -4 \\ -10 \\ 14 \\ -15 \end{pmatrix}$	[6] $\begin{pmatrix} 4 \\ -16 \\ -5 \\ 3 \end{pmatrix}$	[8] $\begin{pmatrix} 12 \\ 16 \\ 14 \\ -15 \end{pmatrix}$	[10] $\begin{pmatrix} -19 \\ -8 \\ 25 \\ -8 \end{pmatrix}$



Question 8

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 7 \\ 0 \\ 0 \\ 1 \end{pmatrix}$; with the basis $B = (1, 4)$.

$$\nabla f(x) = \begin{pmatrix} 9 \\ 10 \\ -7 \\ 4 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} -2 & 1 \\ -2 & 0 \end{pmatrix}, A_N = \begin{pmatrix} 1 & 2 \\ -2 & 1 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

$\boxed{1} \begin{pmatrix} 5 \\ 2 \\ 0 \\ -17 \end{pmatrix}$	$\boxed{3} \begin{pmatrix} 20 \\ 2 \\ 0 \\ -16 \end{pmatrix}$	$\boxed{5} \begin{pmatrix} 1 \\ 26 \\ -22 \\ 8 \end{pmatrix}$	$\boxed{7} \begin{pmatrix} -12 \\ 2 \\ 0 \\ 15 \end{pmatrix}$	$\boxed{9} \begin{pmatrix} 15 \\ 26 \\ -22 \\ 9 \end{pmatrix}$
$\boxed{2} \begin{pmatrix} 10 \\ 20 \\ -1 \\ -5 \end{pmatrix}$	$\boxed{4} \begin{pmatrix} -10 \\ 20 \\ -1 \\ 23 \end{pmatrix}$	$\boxed{6} \begin{pmatrix} -13 \\ 26 \\ -22 \\ -2 \end{pmatrix}$	$\blacksquare \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	$\boxed{10} \begin{pmatrix} 14 \\ 20 \\ -1 \\ 2 \end{pmatrix}$



Question 9

We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 0 \\ 2 \\ 0 \\ 3 \end{pmatrix}$; with the basis $B = (2, 3)$.

$$\nabla f(x) = \begin{pmatrix} 7 \\ 7 \\ 1 \\ 10 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} 0 & 2 \\ 1 & 1 \end{pmatrix}, A_N = \begin{pmatrix} -2 & -2 \\ 1 & 0 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

$\boxed{1} \begin{pmatrix} 29 \\ 9 \\ 12 \\ 20 \end{pmatrix}$	$\boxed{3} \begin{pmatrix} 29 \\ 22 \\ 28 \\ 20 \end{pmatrix}$	$\boxed{5} \begin{pmatrix} -13 \\ -19 \\ -26 \\ -18 \end{pmatrix}$	$\boxed{7} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$	$\boxed{9} \begin{pmatrix} -13 \\ -18 \\ -27 \\ -18 \end{pmatrix}$
$\boxed{2} \begin{pmatrix} 29 \\ -28 \\ 21 \\ 20 \end{pmatrix}$	$\boxed{4} \begin{pmatrix} 6 \\ 6 \\ -22 \\ -12 \end{pmatrix}$	$\blacksquare \begin{pmatrix} 6 \\ -12 \\ -18 \\ -12 \end{pmatrix}$	$\boxed{8} \begin{pmatrix} 6 \\ 17 \\ 2 \\ -12 \end{pmatrix}$	$\boxed{10} \begin{pmatrix} -13 \\ 30 \\ -21 \\ -18 \end{pmatrix}$



Question 10

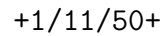
We apply the reduced gradient algorithm on a non linear program with linear constraints and 4 positive variables, and 2 equality constraints. We apply the al-

gorithm starting at $x = \begin{pmatrix} 7 \\ 0 \\ 6 \\ 0 \end{pmatrix}$; with the basis $B = (1, 3)$.

$$\nabla f(x) = \begin{pmatrix} -5 \\ -3 \\ -8 \\ -3 \end{pmatrix}, A_B^{-1} = \begin{pmatrix} 0 & -2 \\ 1 & 1 \end{pmatrix}, A_N = \begin{pmatrix} 2 & 1 \\ 1 & -1 \end{pmatrix}$$

Compute the direction d followed by the algorithm during that iteration.

1 $\begin{pmatrix} -19 \\ 8 \\ -23 \\ -18 \end{pmatrix}$	3 $\begin{pmatrix} -12 \\ 2 \\ 17 \\ 23 \end{pmatrix}$	5 $\begin{pmatrix} -11 \\ 8 \\ 28 \\ -18 \end{pmatrix}$	7 $\begin{pmatrix} 22 \\ 4 \\ 23 \\ 7 \end{pmatrix}$	9 $\begin{pmatrix} -26 \\ 4 \\ 10 \\ 7 \end{pmatrix}$
2 $\begin{pmatrix} 22 \\ 8 \\ -21 \\ -18 \end{pmatrix}$	4 $\begin{pmatrix} 15 \\ 2 \\ -19 \\ 23 \end{pmatrix}$	6 $\begin{pmatrix} 18 \\ 4 \\ 21 \\ 7 \end{pmatrix}$	8 $\begin{pmatrix} 30 \\ 2 \\ -16 \\ 23 \end{pmatrix}$	$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$



Check entirely the 3 first letters of your lastname and the first letter of your firstname. For instance, for Jean Dupont, check J, D, U, P ; for Henri Harley, check only H, A, R ; for Bernard Ca, check only A, B, C.

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QUESTION 10 :

1

2

3

4

5

6

7

8

9

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+1/12/49+