

**Concordia University**  
**Department of Building, Civil and Environmental Engineering**  
**Civil Engineering Systems (CIVI-341) Winter – 2011**

**Midterm II**

**[28 marks in total]**

Instructor: Dr. L. Amador

**SOLUTION**

Due: Tuesday, March 15<sup>th</sup>, 2011

Start 8:45 am. - End 9:55 am

1. Based solely in the information provided in the following basis (in tableau format) determine if the problem is: (a) feasible with a unique solution, (b) unbounded, or (c) it has alternate optima. Explain why [6 marks]

- a. **Maximize (Hint: negative coefficients on Z row = it is still possible to improve)**

Basis	x1	x2	s1	s2	s3	s4	Value
Z	0	0	0	12	0	-18	60
s1	0	0	1	-6	0	-13	24
x1	1	0	0	1	0	-3	30
s3	1	0	0	-1	1	-3	10
x2	0	1	0	0	0	-1	5

**Unbounded because all ratios are negative when trying to bring S4 into the basis**

- b. **Minimize (Hint: positive coefficients on Z row = it is still possible to improve)**

Basis	x1	x2	s1	s2	s3	s4	Value
Z	0	0	-0.66667	0	0	-3	120
x2	0	1	0	0	0	1	6
s2	0	0	0.666667	1	0	0	2
s3	0	0	0.5	0	1	-3.5	0
x1	1	0	-0.16667	0	0	0.5	5

**Unique optima, both non basic coefficients are negative, no further improvement is possible**

- c. **Maximize**

Basis	x1	x2	s1	s2	s3	s4	Value
Z	0	0	0	0	0	18	14
s1	0	0	1	-6	0	-13	0
x1	1	0	0	1	0	-3	5
s3	1	0	0	-1	1	-3	15
x2	0	1	0	0	0	-1	30

**Alternate optima, the coefficient of non basic variable S2 = 0**

2. For the following multi-objective linear program:

$$\text{Maximize } Z_1 = x_1 + x_2$$

$$\text{Minimize } Z_2 = \frac{1}{2}x_1 + x_2$$

$$\text{Subject to: } x_1 + x_2 \leq 10$$

$$x_1 - x_2 \leq 6$$

$$x_2 \leq 8$$

$$x_1 \geq 0$$

$$x_2 \geq 0$$

a) Solve for the first objective using the simplex tableau [9 marks]

Basis	x1	x2	s1	s2	s3	Value	Ratio
Z	-1	-1	0	0	0	0	
s1	1	1	1	0	0	10	10
s2	1	-1	0	1	0	6	6
s3	0	1	0	0	1	8	#DIV/0!

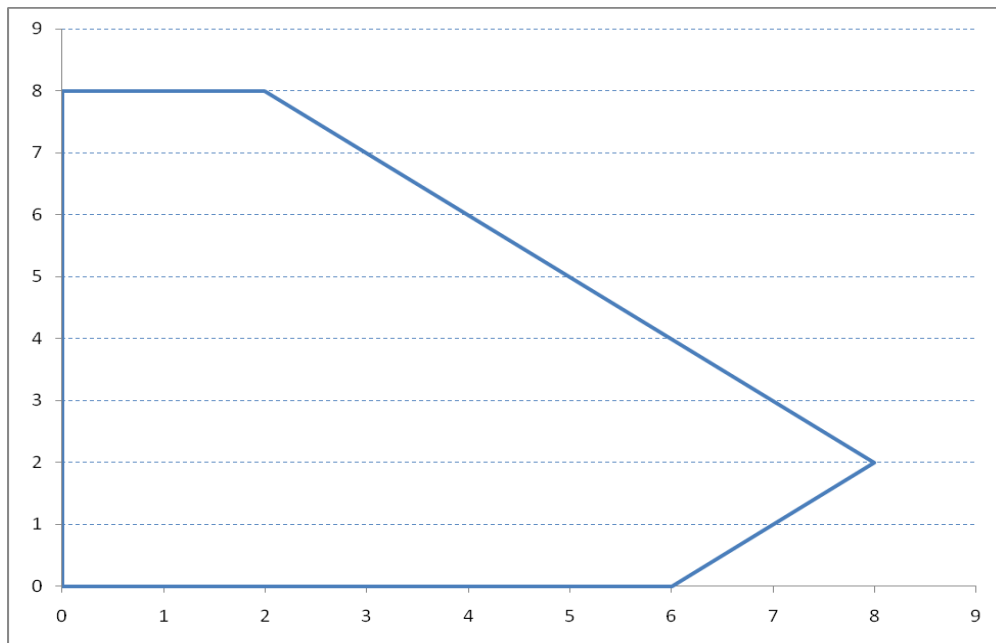
Basis	x1	x2	s1	s2	s3	Value	Ratio
Z	0	-2	0	1	0	6	
s1	0	2	1	-1	0	4	2
x1	1	-1	0	1	0	6	-6
s3	0	1	0	0	1	8	8

Basis	x1	x2	s1	s2	s3	Value	Ratio
Z	0	0	1	0	0	10	
x2	0	1	0.5	-0.5	0	2	-4
x1	1	0	0.5	0.5	0	8	16
s3	0	0	-0.5	0.5	1	6	12

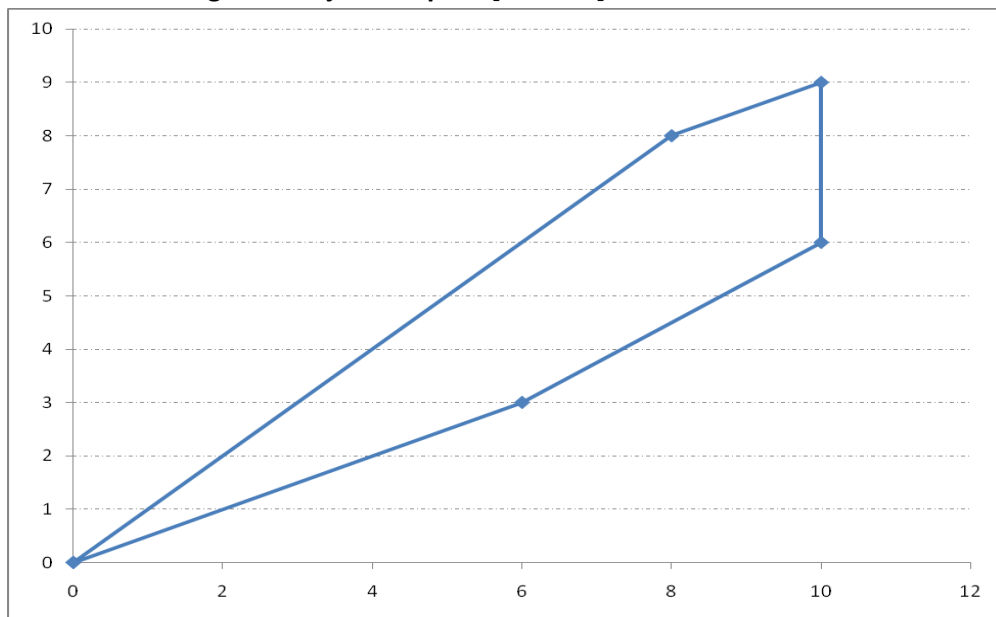
Basis	x1	x2	s1	s2	s3	Value	Ratio
Z	0	0	1	0	0	10	
x2	0	1	0	0	1	8	
x1	1	0	1	0	-1	2	
s2	0	0	-1	1	2	12	

\*Note. You could have started with x2, however should have reach same values at the end

b) Plot the feasible region in decision space [3 marks]



c) Plot the feasible region in objective space [5 marks]



d) For each extreme point indicate if it is a non-inferior or a dominated solution, indicate which alternative dominates it [5marks]

	X1	X2	Max Z1	MIN Z2	Condition
A	0	0	0	0	Non inferior
B	6	0	6	3	Non inferior
C	8	2	10	6	Non inferior
D	2	8	10	9	Dominated by C
E	0	8	8	8	Dominated by C