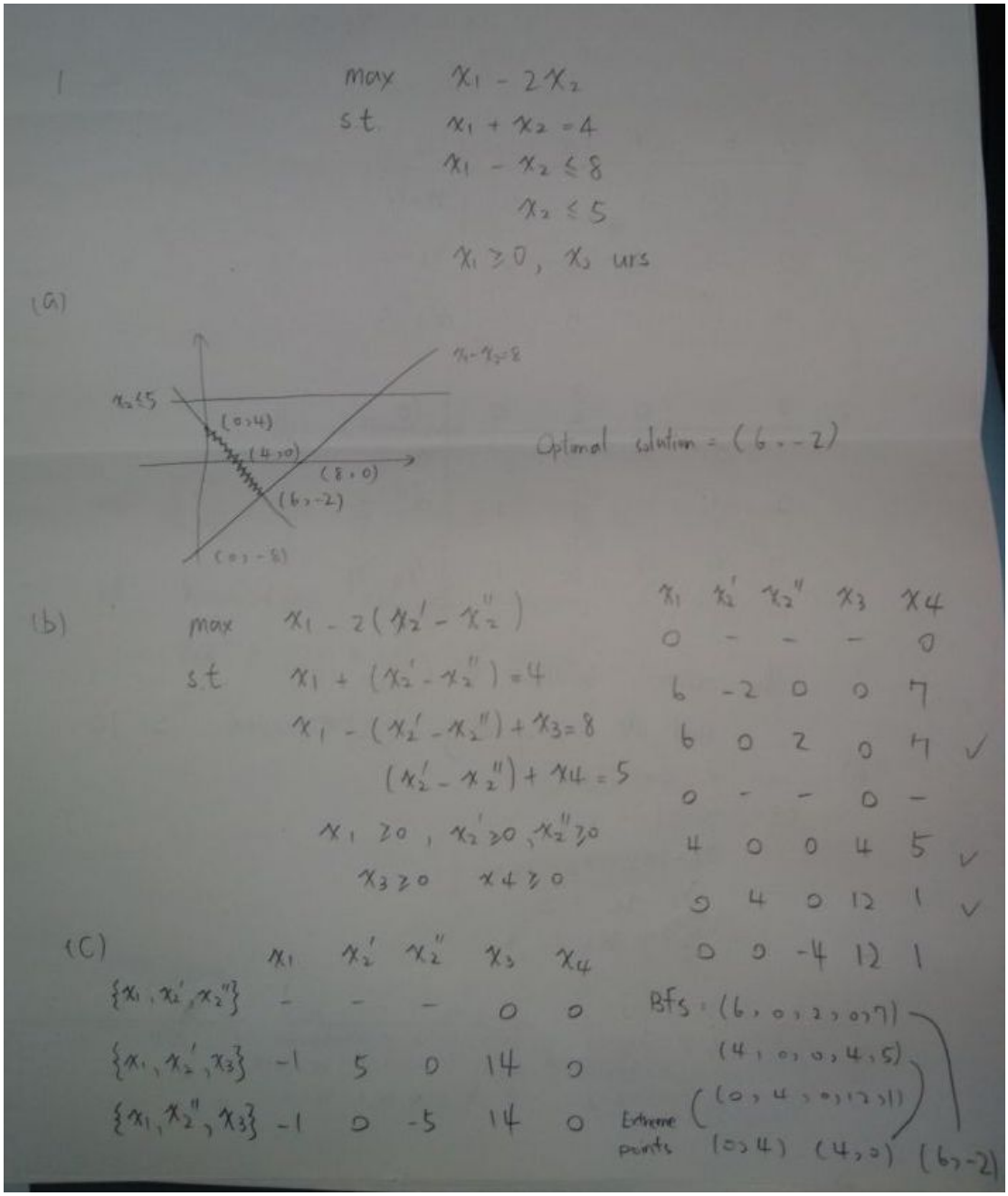
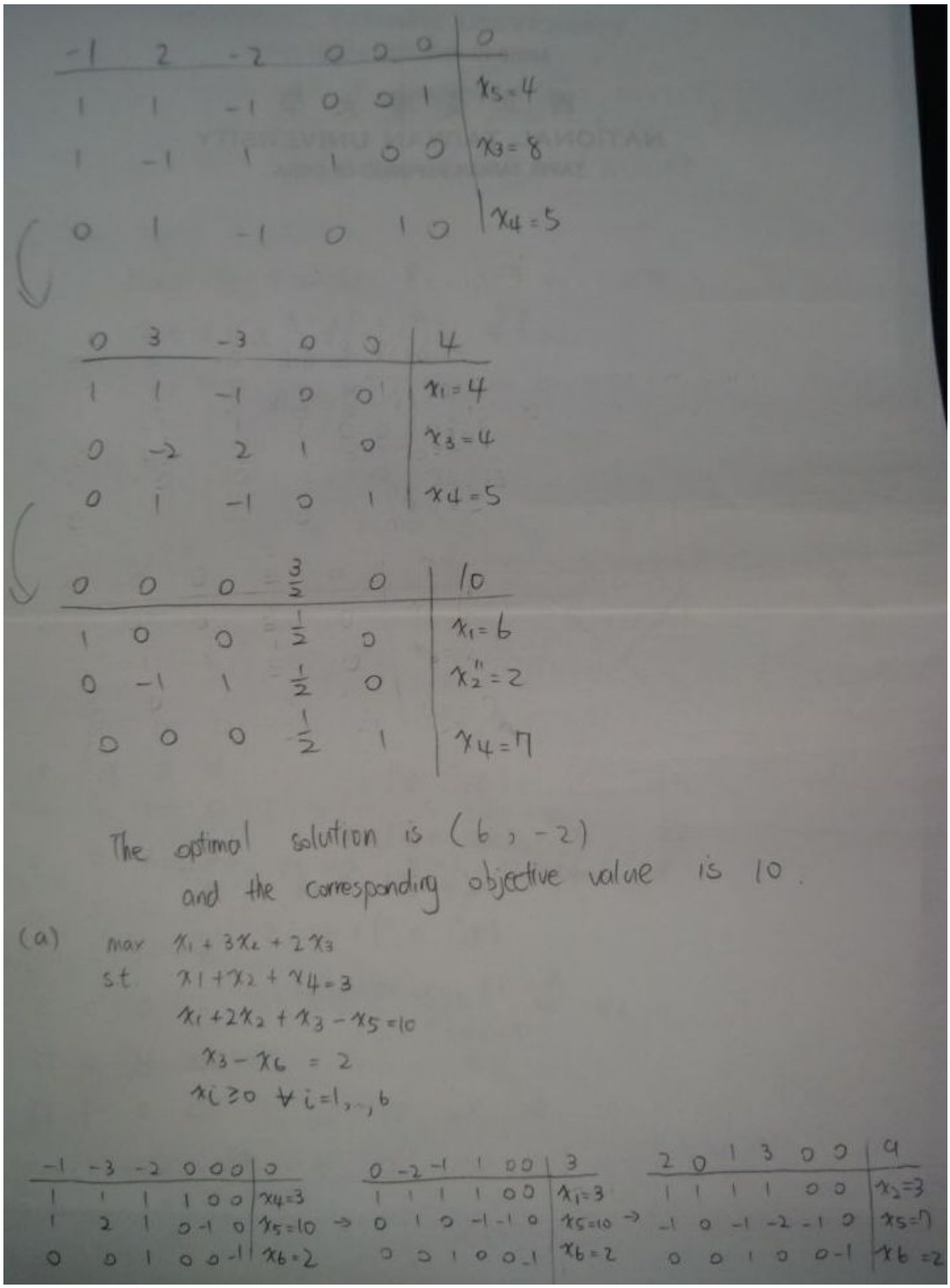
B06705034 資管二 吳禹辰

1. (a)(b)(c)



(d) 2.(a)

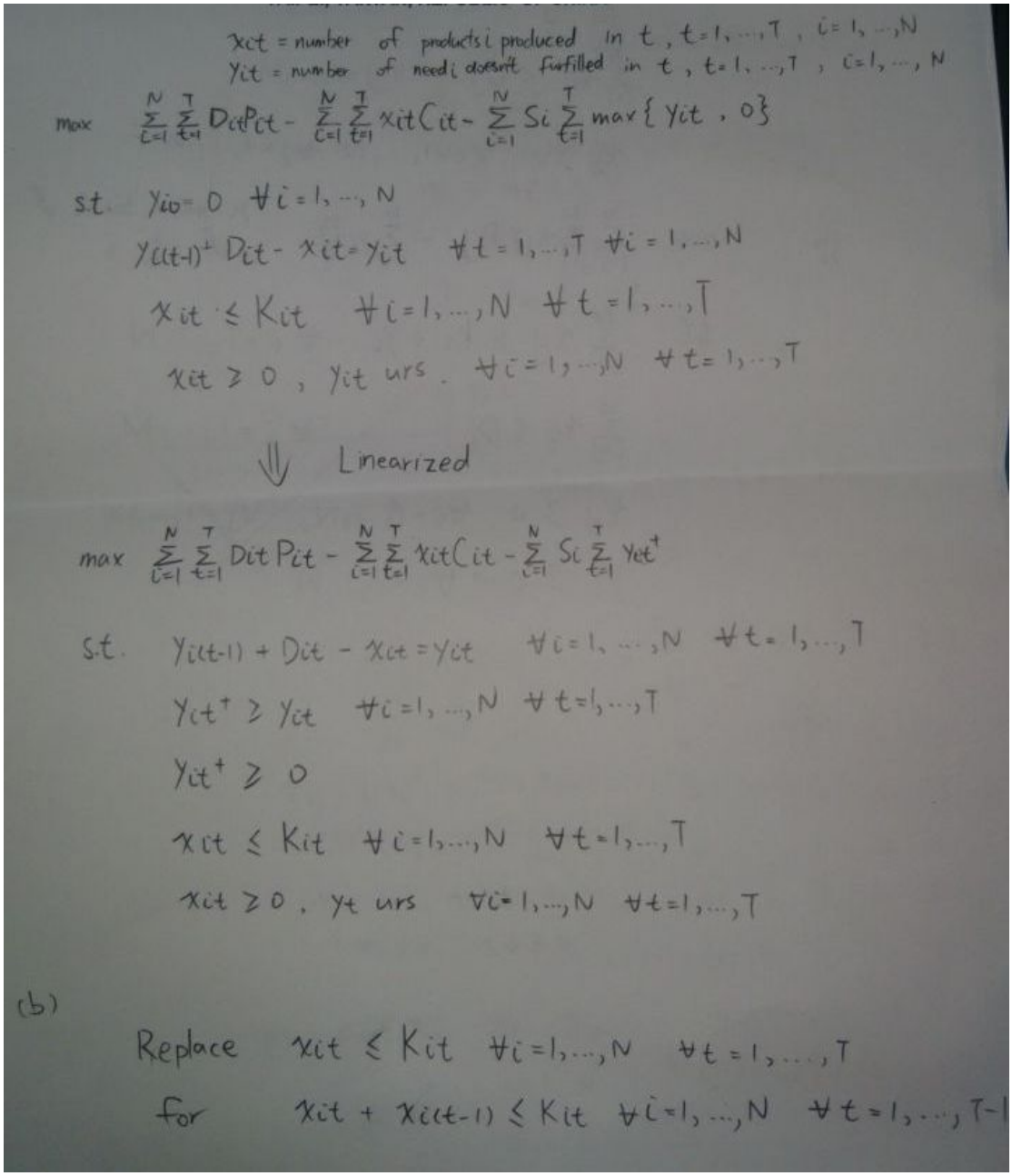


(b) It's unbounded.

```
Gurobi 8.1.0: unbounded; variable.unbdd returned.
2 simplex iterations

suffix unbdd OUT;
```

3.(a)(b)



x_{it} = number of products i produced in t, $t=1,\dots,T$, $i=1,\dots,N$

y_{it} = number of need i doesn't fulfilled in t, $t=1,\dots,T$, $i=1,\dots,N$

$$\max \sum_{i=1}^{N}\sum_{t=1}^{T} D_{it}P_{it} - \sum_{i=1}^{N}\sum_{t=1}^{T} x_{it}C_{it} - \sum_{i=1}^{N} S_i \sum_{t=1}^{T} \max\{y_{it}, 0\}$$

s.t. $y_{i0} = 0 \quad \forall i = 1,\dots,N$

$y_{i(t-1)} + D_{it} - x_{it} = y_{it} \quad \forall t = 1,\dots,T \quad \forall i = 1,\dots,N$

$x_{it} \le K_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

$x_{it} \ge 0$, y_{it} urs. $\forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

⇓ Linearized

$$\max \sum_{i=1}^{N}\sum_{t=1}^{T} D_{it}P_{it} - \sum_{i=1}^{N}\sum_{t=1}^{T} x_{it}C_{it} - \sum_{i=1}^{N} S_i \sum_{t=1}^{T} y_{it}^{+}$$

s.t. $y_{i(t-1)} + D_{it} - x_{it} = y_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

$y_{it}^{+} \ge y_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

$y_{it}^{+} \ge 0$

$x_{it} \le K_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

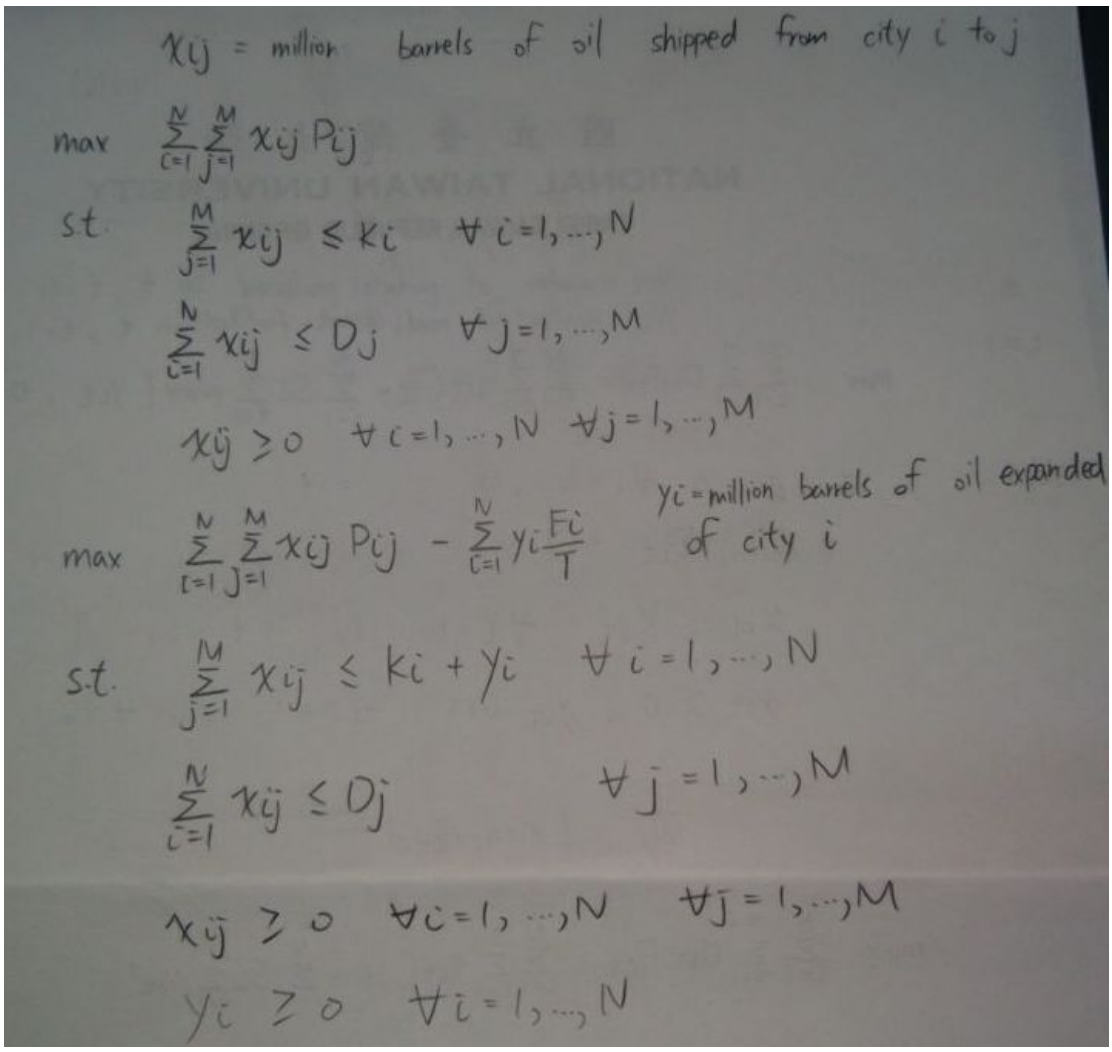
$x_{it} \ge 0$, y_t urs $\quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

(b)

Replace $x_{it} \le K_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T$

for $x_{it} + x_{i(t-1)} \le K_{it} \quad \forall i = 1,\dots,N \quad \forall t = 1,\dots,T-1$

4.(a)(b)



(c)

```
Gurobi 8.1.0: optimal solution; objective 9950
9 simplex iterations
```

(d)

x i j = Millions of barrels of oil shipped from city i to point j

y i = Million barrels of annual refining capacity that is added to city i

T=1,2,3,4

```
optimal solution; objective 8850
x :=
1 1   1
1 2   5
1 3   0
1 4   0
```

```
2 1   6
2 2   0
2 3   0
2 4   0
3 1   0
3 2   0
3 3   7
3 4   0

y [*] :=
1  0
2  0
3  0

T=5
optimal solution; objective 9950
x :=
1 1   1
1 2   7
1 3   1
1 4   8
2 1   6
2 2   0
2 3   0
2 4   0
3 1   0
3 2   0
3 3   7
3 4   0

y [*] :=
1  11
2   0
3   0
```

T=6,7,8,9,10

optimal solution; objective 10683.33333

x :=

1 1 1

1 2 7

1 3 1

1 4 8

2 1 6

2 2 0

2 3 0

2 4 0

3 1 0

3 2 0

3 3 7

3 4 0

y [*] :=

1 11

2 0

3 0

Conclusion:

When T becomes larger, the average annual cost of expanding will be less, so it’s better to expand when T is large enough.