Assignment 2

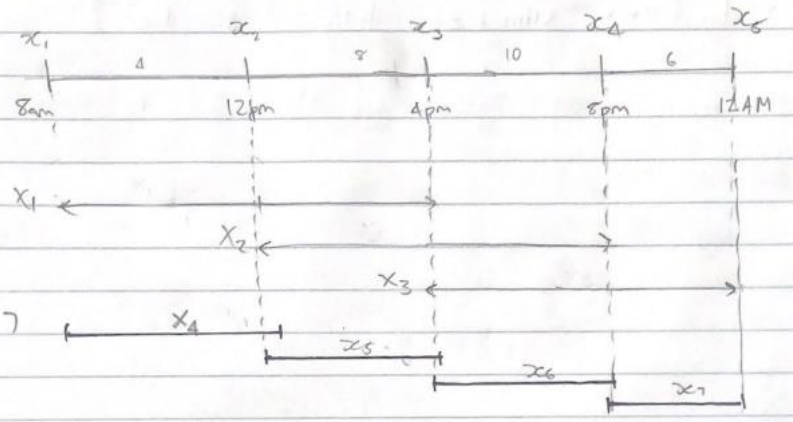
Lukas van der Watt

10/4/2021

QMM Assignment 2.

1)

Fulltime : x_i where i (shift) = 1, 2, 3...



Fulltime — x_i

Part-Time — x_j

where i = 1, 2, 3

j = 4, 5, 6, 7

Min Cost Staffing Plan: Min # of consultants 28 per day.

Minimize $Z = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7$

ST :

Constraints : $x_1 + x_4 \geq 4$

$x_1 + x_2 + x_5 \geq 8$

$x_2 + x_3 + x_6 \geq 10$

$x_3 + x_7 \geq 6$

fulltime $\geq$ Part time

$\therefore x_i \geq x_j$

$x_i \geq 0$

$x_j \geq 0$

So Total # of full time = $\frac{28}{4}$ = 7 employees

$\therefore$ # of Part time = 14 employees

Min cost daily staffing Plan : 8 hour shift @ 14/hr = $112

So for full time = 7 · 112 = $784 cost

for Part time = 14 · 48 = $672 cost

$\therefore$ Min daily Staffing Cost = $784 + $672 = $1456

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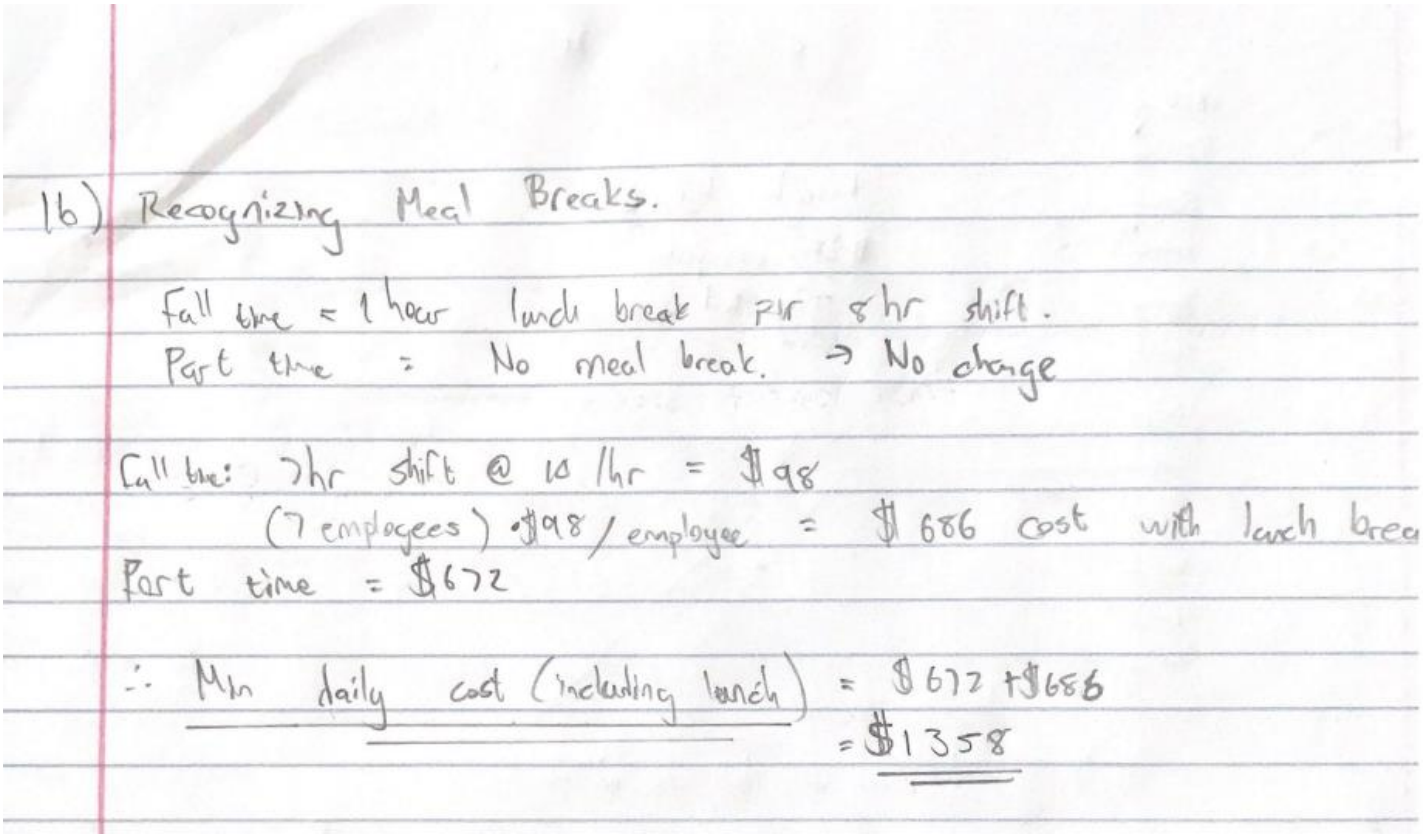

16) Recognizing Meal Breaks.

Full time = 1 hour lunch break per 8 hr shift.
Part time : No meal break. → No change

Full time: 7hr shift @ 14 /hr = $98
(7 employees) · $98 / employee = $686 cost with lunch brea
Part time = $672

∴ Min daily cost (including lunch) = $672 + $686
= $1358

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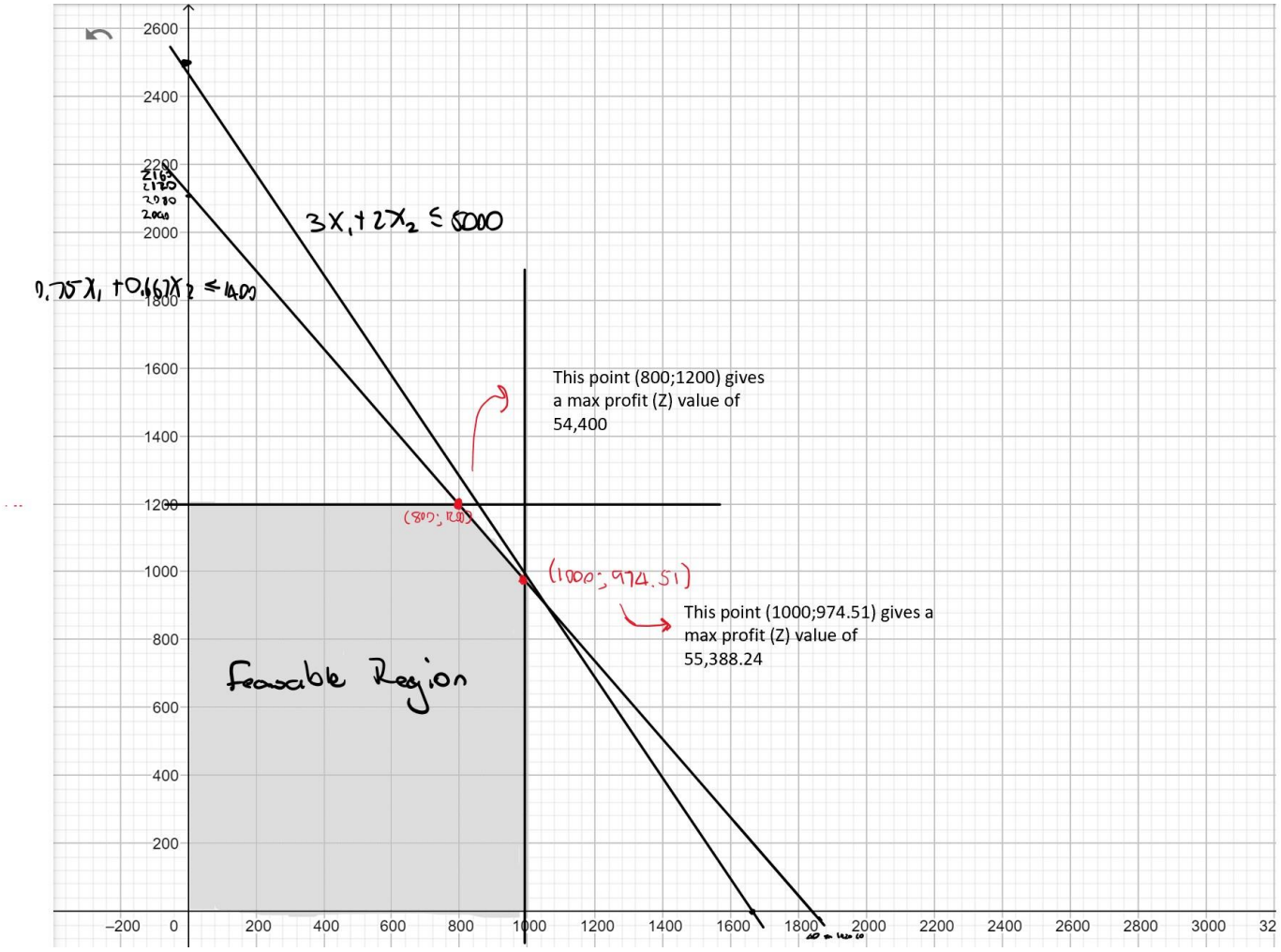
Part 2



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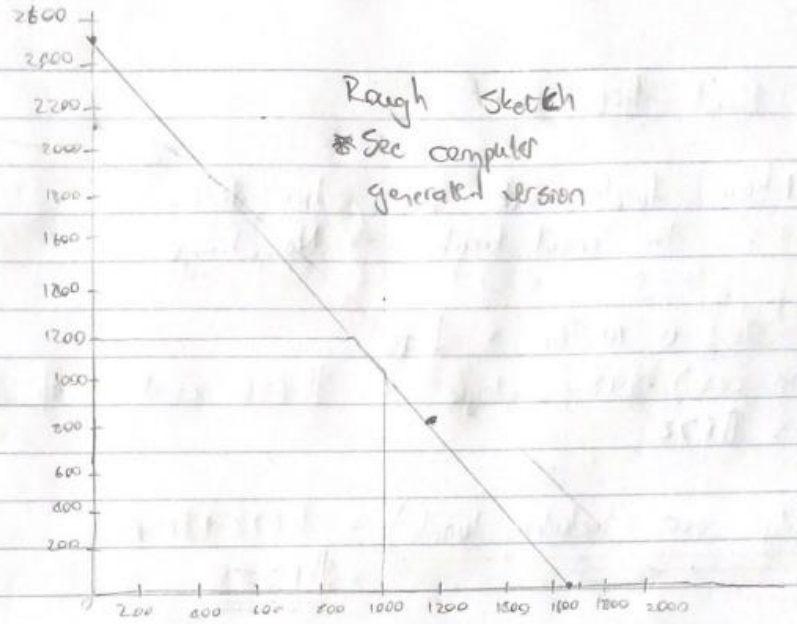

Rough Sketch
* See computer generated version

Y = mx + c

$Z = 32X_1 + 24X_2$ gradient form: $X_2 = \frac{32}{-24}X_1 + \frac{Z}{24}$

Intersection of lines ii & iv → (800; 1200)
Intersection of lines ii & iii → (1000; 974.51)
Intersection of lines i & iv → (866.67; 1200)
Intersection of lines i & iii → (1000; 1000)
Intersection of i & ii → (1067.86; 898.20359)

@ Point (800, 1200) $Z = 32(800) + 24(1200) = \$54\,400$

($\text{Max } Z = 32(1000) + 24(974.51) = \boxed{\$55\,388,24}$

$Z = 32X_1 + 24X_2$

ST i) $3X_1 + 2X_2 \leq 5000$
constraints: ii) $0.75X_1 + 0.667X_2 \leq 1400$ } → Intersects: $X_1 = 1067.86$, $X_2 = 898.20359$

iii) $X_1 \leq 1000$ ✓
iv) $X_2 \leq 1200$ ✓

$X_1 \geq 0$
$X_2 \geq 0$

line Points i) $3(X_1) + 2(X_2) \leq 5000$
(0 ; 2500)
(1666.667 ; 0)

ii) $0.75(X_1) + 0.667(X_2) \leq 1400$
(0 ; 2098.75)
(1866.667 ; 0)

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3)

Plant 1 Plant 2 Plant 3

Max Profit $Z = 420X_{1j} + 360X_{2j} + 300X_{3j}$

	$X_j = 1$ Large	$X_{j=2}$ Medium	$X_{j=3}$ Small	Production Limits (units)	Storage Space	ft^2
$X_j = 1$ Plant 1	X_{11} =	X_{21} =	X_{31} =	750	13 000	
$X_j = 2$ Plant 2	X_{12} =	X_{22} =	X_{32} =	900	12 000	
$X_j = 3$ Plant 3	X_{13} =	X_{23} =	X_{33} =	450	5000	
Profit/unit	$ 420	$ 360	$ 300			

Units Sold per day 900 1200 750

Plant 1 Plant 2

$Z = (420X_{11} + 360X_{21} + 300X_{31}) + (420X_{12} + 360X_{22} + 300X_{32}) +$

$(420X_{13} + 360X_{23} + 300X_{33})$

Plant 3

ST :

$$\left.\begin{aligned} X_{11} + X_{21} + X_{31} &\leq 750 \\ X_{12} + X_{22} + X_{32} &\leq 900 \\ X_{13} + X_{23} + X_{33} &\leq 450 \end{aligned}\right\} \text{Supply}$$

$$\left.\begin{aligned} 20X_{11} + 15X_{21} + 12X_{31} &\leq 13\,000 \\ 20X_{12} + 15X_{22} + 12X_{32} &\leq 12\,000 \\ 20X_{13} + 15X_{23} + 12X_{33} &\leq 5000 \end{aligned}\right\} \text{Storage}$$

$$\left.\begin{aligned} X_{11} + X_{12} + X_{13} &\leq 900 \\ X_{21} + X_{22} + X_{23} &\leq 1200 \\ X_{31} + X_{32} + X_{33} &\leq 750 \end{aligned}\right\} \text{Sold per day Demand}$$

$X_{ij} \geq 0$ for all

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The following is the R code to solve the lp model:

A .lp file was first made containing all the constraints as follows:

```
/* Objective Function */
max:420x11+ 360x21+ 300x31+ 420x12+ 360x22+ 300x32+ 420x13+ 360x23+ 300x33;

/* Constraints */
Supp1: x11 + x21 + x31 < 750;
Supp2: x12 + x22 + x32 < 900;
Supp3: x13 + x23 + x33 < 450;

Stor1: 20x11 + 15x21 + 12x31 < 13000;
Stor2: 20x12 + 15x22 + 12x32 < 12000;
Stor3: 20x13 + 15x23 + 12x33 < 5000;

Dem1: x11 + x12 + x13 < 900;
Dem2: x21 + x22 + x23 < 1200;
Dem3: x31 + x32 + x33 < 750;
```

This .lp file was then written into R-markdown to be used to solve the model

```
library(lpSolve)
library(lpSolveAPI)
x <- read.lp("WeightProduction.lp")
x

## Model name:
##   a linear program with 9 decision variables and 9 constraints

solve(x)

## [1] 0

get.variables(x)

## [1] 350.0000 400.0000   0.0000   0.0000 400.0000 500.0000   0.0000 133.3333
## [9] 250.0000
```