# IE 375 HW1 SOLUTIONS

## 1)

35a) x: # of units

Investment cost (I)= $30000

The unit cost to produce (c)= $26

Selling price (p) = $85

Total cost= Total revenue

I+ c*x = p*x, then x=508.47 ~ 509 (We assume that the number of devices should be countable. However, in a case where the amount of product should be continuous in terms of kilogram or liters, we shouldn't round the amount.)

35b)

Revenue is the total amount of income generated by the sale of goods or services related to the company's primary operations. Profit is the amount of income that remains after accounting for all expenses, debts, additional income streams, and operating costs.

We want to find revenue, not profit.

p*x= $85*509 = $43265

35c) Let p= $100

I + c*x = p*x, then x=405.405 ~ 406

36) In 35a), we found break even volume (x) = 509.

Expected sales in the first year (F)=100

Increasing rate (i)= 40%

n: Amount of year for to recoup the initial investment

$F*(1+(1+i)+(1+i)^2+\ldots+(1+i)^{n-1}) \geq x$

This statement is the sum of a geometric series. Therefore,

$F*(1-(1+i)^n)/(1-(1+i))=100*(1-1.4^n)/(-0.4) \geq x$

After we make the required computations, the smallest n satisfying = 3.30 years. If we assume that n should be an integer, then n ~ 4 years.

## 2)

a) This is a capacity expansion problem.

f(y): cost of opening a plat of capacity y

f(2y): cost of opening a plat of capacity 2y

$\frac{f(2y)}{f(y)}=\frac{k(2y)^a}{ky^a}$=1.68, then $2^a$ =1.68, a= 0.75

k= $\frac{f(y)}{y^a}=\frac{6000000}{10000^{0.75}}=6000$

b)

x: time interval between introduction of successive plants

r: annual discount rate

D: annual increase in demand

$$\frac{rx}{e^{rx}-1}=a=0.75$$

Let rx be u:

$$\frac{u}{e^{u}-1}=a=0.75=f(u)$$

From figure 1.14 (pg.43), rx=u ~0.60 and we know r=0.15, so x=4.

Optimal size = xD=4*2=8 million barrels/year

c)

Optimal  size= min{15000, 8000000/365=21917.81}=15000 barrels/day=5475000 barrels/year

Optimal timing= Optimal  size/D= 5475000/2000000=2.74 year

Optimal cost= f(15000)=6000*(15000)$^{0.75}$= $8132413.03

# 3)

| F1 | F2 | D | ERROR1=F1-D | ERROR2=F2-D | ABSOLUTE ERROR1 | ABSOLUTE ERROR2 |
|---|---|---|---|---|---|---|
| 223 | 210 | 256 | -33 | -46 | 33 | 46 |
| 289 | 320 | 340 | -51 | -20 | 51 | 20 |
| 430 | 390 | 375 | 55 | 15 | 55 | 15 |
| 134 | 112 | 110 | 24 | 2 | 24 | 2 |
| 190 | 150 | 225 | -35 | -75 | 35 | 75 |
| 550 | 490 | 525 | 25 | -35 | 25 | 35 |

| SQUARE ERROR1 | SQUARE ERROR 2 | ABSOLUTE(ERROR1/D) | ABSOLUTE(ERROR2/D) |
|---|---|---|---|
| 1089 | 2116 | 0.13 | 0.18 |
| 2601 | 400 | 0.15 | 0.06 |
| 3025 | 225 | 0.15 | 0.04 |
| 576 | 4 | 0.22 | 0.02 |
| 1225 | 5625 | 0.16 | 0.33 |
| 625 | 1225 | 0.05 | 0.07 |

| | |
|---|---|
| MAD1 | 37.17 |
| MSE1 | 1523.50 |
| MAPE1 | 14.12 |
| MAD2 | 32.17 |
| MSE2 | 1599.17 |
| MAPE2 | 11.61 |

n=number of periods and i={1,2,…,n};

$F_i$: Forecast for the period i

$D_i$: Demand in period i

$e_i$ (error term for period i) = $F_i$-$D_i$

MAD= $\frac{1}{n}\sum_{i=1}^{n}|e_i|$

MAPE=$(\frac{1}{n}\sum_{i=1}^{n}|e_i/D_i) * 100|$

MSE=$\frac{1}{n}\sum_{i=1}^{n} e_i^2$

In terms of MAD and MAPE, Method2 is more effective, but method 1 is more effective in terms of MSE. These measures define different methods as effective because MSE is similar to the variance of a random sample and require squaring. The MAD and MAPE do not require squaring. Due to squaring, extreme error terms strongly increase the value of MSE such as 75, error term for the second method in the sixth period. If we take the square root of MSE values, $(MSE1)^{0.5}$= 39.03 and $(MSE2)^{0.5}$ = 39.99, so the difference between these two values is smaller than the difference between MSE values.