ISyE 3104 MIDTERM 1 SOLUTIONS

1.a. 2 years: cost when outsourced = 750 x 1,000 x 24 = 18,000,000

cost when produced in house = 5,000,000 + 1,000 x 24 x 0.6 x 750 = 15,800,000

⇒ It is worth producing in house.

1.b. 5,000,000 + 1000 x 24 x 0.7 x P* = 750 x 1,000 x 24 x 0.7

=> P* = $452.38

1.c. $5,000,000 + \sum_{x=1}^{n}(500 - \frac{x}{1000}) = 750 \times n$

$5,000,000 + 500n - \frac{1}{10,000} \times \frac{n(n+1)}{2} = 750n$

$\frac{n^2+n}{20,000} + 250n - 5,000,000 = 0$

⇒ $n \cong 19,921$

Also OK, if understood cost of producing X units (not X^{th} unit) is 500 – x/1000 ;

750 x = 5,000,000 + (500 – x / 1000) x

x^2 / 1000 + 250x -5,000,000 = 0

x = 18,615

2.a. $2^{-b} = 0.92$ => b = 0.12

Y(1) = 120 min.

120 = a X 1^{-b} => a = 120

Y(500) = 120 X 100^{-b} = 56.82 minutes = 0.947 hours

2.b. 45 = 120 x 100^{-b} => b = 0.213 => it does not fiy

ln(Y(u)) = ln(a) –b *ln(u)

y(1) =120 => ln(Y(1)) = 4.7875 ln(1) =0

Y(1000) = 45 => ln(Y(1000)) = 3.807 ln(1000) = 6.908

$$\frac{Y - Y_1}{X - X_1} = \frac{Y_2 - Y_1}{X_2 - X_1}$$ => finding equation of line

$$\frac{\ln(Y(u)) - 4.4875}{\ln(u) - 0} = \frac{3.807 - 47875}{6.908 - 0}$$

6.908ln(Y(u)) -33,702 = -0.9805 x ln(u)

ln(Y(u)) = 4.7875 – 0.142 x ln(u)

$$2^{-b} = 2^{-0.142} = 0.906 = 90.6\%$$

Also OK if found new b by ;

Y(1000) = 2 x (1000) $^{-b}$ = 0.75 hour

(1000) $^{-b}$ = 0.75/2

b = 0.142

$L^{new} = 2^{-b} = 2^{-0.142}$ = 90.6%

3.a. annual demand = 75 x 52 = 3,900 units

$$Q^* = \sqrt{\frac{2 \times 20 \times 3900}{0.2 \times 1.5}} \cong 721$$

$$T = \frac{Q}{D} = \frac{721}{3900}$$ = 0.185 years = 9.61 weeks

3.b. If 4 orders per year,

T = ¼ years

$$\frac{1}{4} = \frac{Q}{3900} \Rightarrow Q = 975$$

$$975 = \sqrt{\frac{2 \times K \times 3900}{0.2 \times 1.5}}$$ => K = 36.56

4.a. K = $100

h = $2/year

P = 8,000 unit / year

d = 2,000 unit / year

$$Q^* = \sqrt{\frac{2 \; x \; 100 \; x \; 2{,}000}{2x\left(1-\frac{2{,}000}{8{,}000}\right)}} \cong 517$$

4.b. H = $517 \; x \left(1-\frac{2{,}000}{8{,}000}\right) \cong 388$

4.c. $T_1 = \frac{Q}{P} = \frac{517}{8{,}000} = 0.064625 \; years = 3.3605 \; weeks$

4.d. . $T = \frac{Q}{d} = \frac{517}{2{,}000} = 0.2585 \; years = 13.442 \; weeks$

$T_2 = T - T_1 = 10{,}0815 \; weeks$

5.a. A worker can produce $\frac{7}{2.5} x \; 20 = 56 \frac{units}{month}$

Cumulative production per worker	cumulative demand	# of workers required	cumulative prodn.	ending inventory
56	6750	121	6,776	26
112	10,750	96	13,552	2,802
168	17,750	106	20,328	2,578
224	21,750	97	27,104	5,354 + 500

Fire 200 -121 = 79 workers at the beginning

Total cost = 79 x 2,500 + 30 x 7 x 20x 121 x 4 + (26 x 2,802 + 2,578 + 5,354 + 500) x 15

Firing cost worker cost inventory holding cost

= 197,500 + 2,032,800 + 16,890

= 2,399,200

5.b.

Prodn per worker	Demand	# of workers required	Cumulative ending inventory	Hire	Fire

56	6,750	121	26		79
56	4,000	72	58		49
56	7,000	125	58	53	
56	4,000	72	90 + 500		53

Total cost = (79 + 49 + 53) x 2,500 + 53 x 1,250 + 7 x 30 x 20 x 121 + 7 x 30 x 20 x 72 + 7 x 30 x 20 x 125

+ 7 x 30 x 20 x 72 + (26 + 58 + 58 + 90 + 500) x 15 = 2,167,730

5.c. From part a, apply a constant workforce plan with 106 workers (2nd highest). Fire 94 workers at the beginning

Cumulative production	Ending inventory	Backorder
5,936	-	814
11,872	308	-
17,808	58	-
23,744	1,994 + 500	-

Total cost = 94 x 2,500 + 30 x 7 x 20 x 106 x 4 + (308 + 58 + 1,994 + 500) x 15 + 814 x 50

= 2,099,400

6.a. No, because the EOQ model is for systems which have constant demand. However, in this case demand is seasonal.

6.b. Uncertainties, speculators, economies of scale

6.c. (b)

6.d. (c)

6.e. (c)