Name (print, please) ____ ID _________________________

Operations Management I 73-331 Winter 2001
Faculty of Business Administration
University of Windsor

Final Exam
Tuesday, April 17, Noon – 3:00 p.m.
Faculty of Education Neal Building Room 1101

Instructor: Mohammed Fazle Baki
Aids Permitted: Calculator, straightedge, and a both-sided formula sheet.
Time available: 3 hours
Instructions:

- This exam has 11 pages including this cover page and 1 page of Table
- Please be sure to put your name and student ID number on each page.
- Show your work.

Grading:

Question	Marks:
1	/2
2	/4
3	/6
4	/6
5	/10
6	/8
7	/4
8	/6
9	/4
10	/5
11	/5
Total:	/60

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Question 1: (2 points)

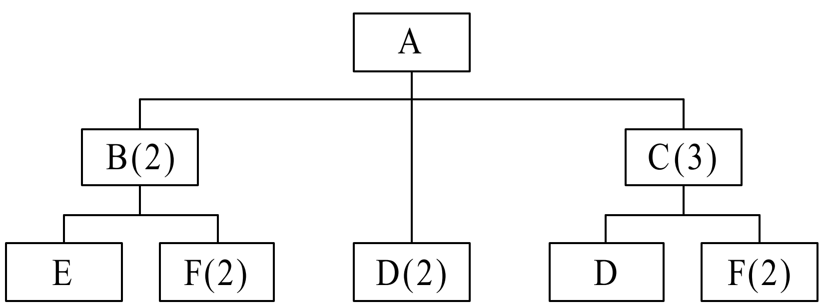
A supplier of instrument gauge clusters uses a kanban system to control material flow. The gauge cluster housings are transported five at a time. A fabrication centre produces approximately 10 gauges per hour. It takes approximately two hours for the housing to be replenished. Due to variations in processing times, management has decided to keep 25 percent of the needed inventory as safety stock. How many kanban card sets are needed?

$$y = \frac{DL + w}{a} = \frac{10 \times 2 + 0.25 \times 10 \times 2}{5} = 5$$

Question 2: (4 points)

One unit of A is made of two units of B, three units of C, and two units of D. B is composed of one unit of E and two units of F. C is made of two units of F and one unit of D.

a. (2 points) Construct a product structure tree.



b. (2 points) Suppose that the gross requirement of A is 100 units. Items A, C and D have on-hand inventories of 25, 50 and 75 units respectively. Find the net requirement of D.

Gross requirement, A		100 units
Less on hand, A	25	
Net requirement, A		100 – 25 = 75
Gross requirement, C (=3A)		75×3 =225
Less on hand, C		50
Net requirement, C		225 – 50 = 175
Gross requirement, D (=2A+C)		$2\times75+175 = 325$
Less on hand, D		75
Net requirement, D		325 – 75=250

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Question 3: (6 points)

The MRP gross requirements for Item X are shown here for 4 weeks. Lead time for A is one week, and setup cost is $9. There is a carrying cost of $0.20 per unit per week. Beginning inventory is 20 units in Week 1.

	Week			
	1	2	3	4
Gross requirements	20	10	15	45

a. (3 points) Use the EOQ method to determine when and for what quantity the *first order* should be released.

$K = \$9$, $h = 0.20 \times 52 = \$10.40$ per unit per year

Since 4-week demand is 20, 10, 15 and 45, 52-week demand, $\lambda = (20+10+15+45)\frac{52}{4} = 1170$ units

EOQ = $\sqrt{\frac{2\times9\times1170}{10.40}} = 45$ units

Hence, order 45 units. Since the beginning inventory of 20 units can cover Week 1, the first order must be received in Week 2. Since there is a lead-time of 1 week, the order must be placed in Week 1. Hence, order 45 units in Week 1.

b. (3 points) Use the Silver-Meal heuristic to determine when and for what quantity the *first order* should be released.

Since the beginning inventory of 20 units can cover Week 1, the gross requirements for which order must be placed are the demands of Weeks 2, 3 and 4 i.e., 10, 15 and 45 units.

Order for weeks	Order quantity, Q	Inventory at the end of Week 2	Inventory at the end of Week 2	Inventory at the end of Week 2	Holding cost	Ordering cost	Per period cost
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6+7)÷1
1	10	0			0	$9	(0+9)/1=$9
2	10+15= 25	15	0		15×0.20 =$3	$9	(3+9)/2=$6
3	25+45= 70	60	45	0	(60+45) ×0.20 =$21	$9	(21+9)/3 =$10 Increased, Stop.

Per period cost is minimum $6, for an order quantity of 25 units. Hence, order 25 units. The first order must be received in Week 2. Since there is a lead-time of 1 week, the order must be placed in Week 1. Hence, order 25 units in Week 1.

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Question 4: (6 points)

Following are the net requirements and production capacities of a product:

	Month			
	1	2	3	4
Net requirements	30	50	100	40
Production capacities	80	80	80	80

a. (2 points) Find a feasible production plan, if there exists any.

On the first trial, plan 30 and 50 units in Months 1 and 2 respectively.

But, Week 3 requirement is (100-80=) 20 units more than the capacity.

Hence, 20 units of Month 3 must be back-shifted to a previous month such as Month 2.

On the second trial, plan 30, 50+20=70, 80 and 40 units in Months 1, 2, 3 and 4 respectively.

b. (2 points) Suppose that the setup cost is $250 and holding cost is $2/unit/month. If possible, show an improvement of the production plan obtained in *a*.

Consider back-shifting Month 4 production quantity of 40 units.

There are excess capacities in Months 1 and 2 and it is possible to back-shift 10 units to Month 2 and 30 units to Month 1. When this is done,

Holding cost added = 10 units × 2 months ×$2/unit/month + 30 units × 3 months ×$2/unit/month = $220 < 250 = ordering cost saved.

Hence, back-shift shift 10 units to Month 2 and 30 units to Month 1. When this is done, the modified production plan is 30+30=60, 70+10=80, 80 units in Months 1, 2 and 3 respectively. (no production in Month 4!!!)

c. (2 points) If the production capacities change to 55 units per month, can you find a feasible production plan?

	Month			
	1	2	3	4
Net requirements	30	50	100	40
Cumulative requirement	30	80	180	220
Production capacities	55	55	55	55
Cumulative production capacity	55	110	165	220

The cumulative requirement in Month 3 is more than the cumulative production capacity. hence, there is no feasible production plan with production capacity of 55 units per month. The first month of shortage will be Month 3.

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Question 5: (10 points)

Mean and standard deviation of annual demand are 300 and 20 units respectively. Lead-time is 3 months. Suppose that a (Q, R) policy is used with $(Q, R) = (100, 94)$.

a. (2 points) Find the number of units of the safety stock.

Lead-time demand, $\mu = \lambda\tau = 300\frac{3}{12} = 75$ units.

However, the reorder point, $R = 94$ units.

The excess, $R - \mu =$ 94-75=19 units is the safety stock.

b. (4 points) What is the probability of stockout during the lead time?

Lead-time standard deviation = $\sigma\sqrt{\tau} = 20\sqrt{3/12} = 10$

$P(\text{lead - time demand} \geq \text{R})$

$$= P\left(z \geq \frac{R-\mu}{\sigma}\right) = P\left(z \geq \frac{94-75}{20\sqrt{3/12}}\right)$$

$$= P(z \geq 1.90) = P(0 \leq z \leq \infty) - P(0 \leq z \leq 1.90) = 0.50 - 0.4713 = 0.0287$$

c. (2 points) What is the expected annual number of orders?

Annual number of orders = $\lambda / Q = 300/100 = 3$

d. (2 points) What is the average inventory?

Average inventory = $Q/2 +$ Safety stock =100/2+19 = 69 units.

Question 6: (8 points)

Jills Job Shop buys two parts (Tegdiws and Widgets) for use in its production system from two different suppliers. The parts are needed throughout the entire 52-week year at a fairly constant rate. Consider the following information:

Item	Tegdiw	Widget
Annual demand	10,000	5,000
Holding cost	20%	20%
Order cost	$150	$25
Item cost	$10.00	$2.00

a. (2 points) Compute EOQ for Tegdiw

$$\text{EOQ}_T = \sqrt{\frac{2K\lambda}{Ic}} = \sqrt{\frac{2\times150\times10{,}000}{0.20\times10}} = 1{,}225 \text{ units}$$

b. (2 points) Compute EOQ for Widget

$$\text{EOQ}_W = \sqrt{\frac{2K\lambda}{Ic}} = \sqrt{\frac{2\times25\times5{,}000}{0.2\times2}} = 790.57 \text{ units}$$

c. (2 points) If EOQ units are ordered, what is the maximum required investment in the inventory of these two parts.

Maximum required investment = $\text{EOQ}_T c_T + \text{EOQ}_W c_W = 1{,}225 \times 10 + 790.57 \times 2 = \$13{,}831$

d. (2 points) If Jills Job Shop does not want to invest more than $10,000 in the inventory of these two parts, find the optimal order quantities.

$m = 10{,}000 / 13{,}831 = 0.723$

$Q_T = m\text{EOQ}_T = 0.723 \times 1{,}225 = 885$ units

$Q_W = m\text{EOQ}_W = 0.723 \times 791 = 572$ units

Question 7: (4 points)

A manufacturer of snack foods has gathered the following information about its Taco chip line, which works 300 days per year.

Daily production	3000 bags
Daily demand	2100 bags
Cost per bag	0.57
Holding cost percentage (annual)	27%
Setup cost	$320

a. (2 points) What is the economic production lot size?

$$Q^* = \sqrt{\frac{2K\lambda}{Ic\left(1-\frac{\lambda}{P}\right)}} = \sqrt{\frac{2\times 320\times(2{,}100\times 300)}{0.27\times 0.57\left(1-\frac{2{,}100\times 300}{3{,}000\times 300}\right)}} = 93{,}420 \text{ units}$$

b. (2 points) What is the total annual cost of this policy?

$$TC = \frac{Q^* h\left(1-\frac{\lambda}{P}\right)}{2} + \frac{K\lambda}{Q^*} = \frac{93{,}420(0.27\times 0.57)\left(1-\frac{2{,}100\times 300}{3{,}000\times 300}\right)}{2} + \frac{320\times 2{,}100\times 300}{93{,}420}$$
$$= 2{,}156.601 + 2{,}157.996 = 4{,}314.6$$

Question 8: (6 points)

Suppose that a 70 percent experience curve is an accurate predictor of the cost of producing a new product. Suppose that the cost of the first unit is $500.

$b = -\ln(.70)/\ln(2) = 0.5146$

a. (2 points) What is cost of the 2nd unit? $Y(u) = au^{-b}, Y(2) = 500(2)^{-0.5146} = \$350$ or, 500*0.7=$350

b. (2 points) What is the cost of the 4th unit? $Y(u) = au^{-b}, Y(4) = 500(4)^{-0.5146} = \$245$ or, 350*0.7=$245

c. (2 points) What is the cost of the 5th unit? $Y(u) = au^{-b}, Y(5) = 500(5)^{-0.5146} = \$218.4$

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Question 9: (4 points)

Based on past experience, an oil company estimates that the construction cost of new refineries obeys a law of the form $f(y)=ky^{0.65}$, where y is measured in barrels per day, $f(y)$ in millions of dollars and k is a constant.

a. (2 points) If the size of the refinery is doubled, what is the percentage increase in the construction costs?

$$\frac{f(2y)}{f(y)}=\frac{k(2y)^{0.65}}{ky^{0.65}}=2^{0.65}=1.57$$

Hence, the cost increases by 57%.

b. (2 points) If a plant size of 20,000 barrels per day costs 10 million dollars, find k.

$f(y)=10$ million dollars

$y=20{,}000$ barrels per day

Hence, $k=\frac{f(y)}{y^{0.65}}=\frac{10}{(20{,}000)^{0.65}}=0.016$

Question 10: (5 points)

Suppose that demand for the last two months are as follows:

Month	Actual Demand
1	31
2	34

a. (3 points) Calculate the double exponential smoothing forecasts (Holt's method) for months 1-2 assuming $\alpha=0.30$, $\beta=0.30$, $S_0=30$, $G_0=1$.

Month, t	Demand, D_t	$S_t=\alpha D_t+(1-\alpha)(S_{t-1}+G_{t-1})$	$G_t=\beta(S_t-S_{t-1})+(1-\beta)G_{t-1}$	$F_{t-1,t}=S_{t-1}+G_{t-1}$
1	31	$S_1=$.3(31)+(.7)(30+1)=31	$G_1=$.3(31-30)+.7(1)=1	$F_{0,1}=30+1=31$
2	34	$S_2=$.3(34)+.7(31+1)=32.6	$G_2=$.3(32.6-31)+.7(1) =1.18	$F_{1,2}=$31+1=32

b. (1 point) $F_{2,3}=?$

$$F_{2,3}=S_2+G_2=32.6+1.18=33.78$$

c. (1 point) $F_{2,5}=?$

$$F_{t,t+\tau}=S_t+\tau G_t$$

$$F_{2,5}=F_{2,2+3}=S_2+3G_2=32.6+3\times1.18=36.14$$

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Question 11: (5 points)

The Easty Brewing Company produces a popular local beer known as Iron Stomach. Beer sales are somewhat seasonal, and Yeasty is planning its production and manpower levels on March 31 for the next six months. The demand forecasts are

Month	Production days	Forecasted Demand
April	11	8,500
May	22	9,300
June	20	12,200
July	23	17,600
August	16	14,000
September	20	6,300

As of March 31, Yeasty had 86 workers on the payroll. Over a period of 20 working days when there were 100 workers on the payroll, Yeasty produced 12,000 cases of beer. As of March 31, Yeasty expects to have 4,500 cases of beer in stock. It plans to start October with 3,000 cases on hand. Based on this information, find the minimum constant workforce plan (level strategy) for Yeasty over the six months.

First, compute the productivity. Over a period of 20 working days when there were 100 workers on the payroll, Yeasty produced 12,000 cases of beer. Hence, productivity

$= \frac{12{,}000}{20 \times 100} = 6$ cases per worker per day

Month	Net Requirement	Cumulative net requirement	Production units per worker	Cumulative production units per worker	Workers needed =
(1)	(2)	(3)	(4)	(5)	(6)=3÷5, round up
April	8,500-4,500 =4,000	4,000	11(6)=66	66	$\lceil 4000/66 \rceil = 61$
May	9,300	13,300	22(6)=132	198	$\lceil 13300/198 \rceil = 68$
June	12,200	25,500	20(6)=120	318	$\lceil 25500/318 \rceil = 81$
July	17,600	43,100	23(6)=138	456	$\lceil 43100/456 \rceil = 95$
August	14,000	57,100	16(6)=96	552	$\lceil 57100/552 \rceil = 104$
Sept	6,300+3,000 =9,300	66,400	20(6)=120	672	$\lceil 66400/672 \rceil = 99$

Maximum in column (6) is 104 in August implying that if there are fewer than 104 workers, then there will be shortage in August. Since, all the other numbers in column (6) are less than 104, there will be no shortage in any other month with 104 workers. Hence, minimum workers required is 104. Hire 104-86=18 workers.