NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2013-2014

MP4F06 – ENGINEERING LOGISTICS

November/December 2013 Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 4 pages.
2. Answer all 4 questions.
3. Marks for each question are as indicated.
4. This is a **Restricted Open-Book** Examination. One double-sided A4 reference sheet is allowed.

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1 A Singapore-based baby food manufacturer has found a high correlation between its annual sales and the number of births nationally in the preceding year. Table 1 shows the sales of the baby food and birth figures of Singapore in the past 5 years (year 5 is the most recent year).

Table 1

	Year				
	1	2	3	4	5
Sales (in $ 1000)	99	92	85	72	68
Birth (in thousands)	35	34	31	29	28

(a) Use a simple exponential smoothing with $\alpha = 0.25$ to forecast the number of births in Singapore next year (assuming one step forecast).

(10 marks)

(b) Develop a linear regression model to forecast the sales of the baby food for next year.

(10 marks)

2 (a) SGR is a Singapore-based retailer that sells a particular brand of scooters, which are produced by a manufacturer in China. The scooters are shipped to SGR through a third party logistics company. For each order, the logistics company charges a fixed fee of \$1,000 per order plus a variable fee of \$10 per scooter (for example, if the SGR orders 500 units, the shipping cost charged by the logistics company would be $1000+10\times500 = 6000$). The demand for the scooters is stable at 750 units per week. The cost of the scooter is \$50 per unit. The retail price that SGR sells the scooter is \$99 per unit. The annual (52 weeks) inventory holding cost rate for SGR is 20%.

Determine the optimal order size for SGR to minimize the total cost (including shipping and inventory holding cost).

(15 marks)

(b) Kevin's retail shop sells a particular type of industrial tape. The demand for the tape is fairly stable at 600 units per year. Kevin purchases the tape from a distributor. The distributor offers discounts based on the size of an order. More specifically, for orders of less than 500 units, the price is 0.3 dollars per unit; for orders of 500 or more but fewer than 1000, the price is 0.29 dollars per unit; for orders of 1000 or more, the price is 0.28 dollars per unit. There is also a fixed cost of \$8 for placing an order. The annual inventory holding cost rate is 20%.

Determine the optimal order size for Kevin to minimize the total cost (including purchasing, ordering, and inventory holding cost).

(15 marks)

(c) HomeAppliance sells a particular type of vacuum cleaner. The unit cost of a vacuum cleaner is 100 dollars. The monthly demand for the vacuum cleaners follows a normal distribution with mean 800 units and standard deviation of 100 units. HomeAppliance purchases the vacuum cleaners from a manufacturer in China. The lead time for order delivery is 2 weeks. The fixed cost of placing an order is 500 dollars. The annual inventory holding cost rate for HomeAppliance is 25%. HomeAppliance uses a base stock policy to manage the inventory of the vacuum cleaners and aims to achieve a service level (type-I) of 99% (the z-value of a standard normal distribution corresponding to 0.99 is 2.33). Due to scheduling constraint, HomeAppliance can only place orders on a monthly or quarterly basis. In other words, orders can only be placed at the beginning of a month or a quarter.

Assuming there are 4 weeks in a month, 3 months in a quarter, and 4 quarters in a year, determine if HomeAppliance should replenish the inventory of the vacuum cleaner monthly or quarterly. Show the steps of your calculations to justify your answer.

(15 marks)

3 Write out the formulation of the maximum covering problem for the network shown in Figure 1 using a coverage distance of 18 if we are to locate P facilities. The number in a square indicates the associated node's demand. What is the formulation if the coverage distance is increased to 20?

(20 marks)

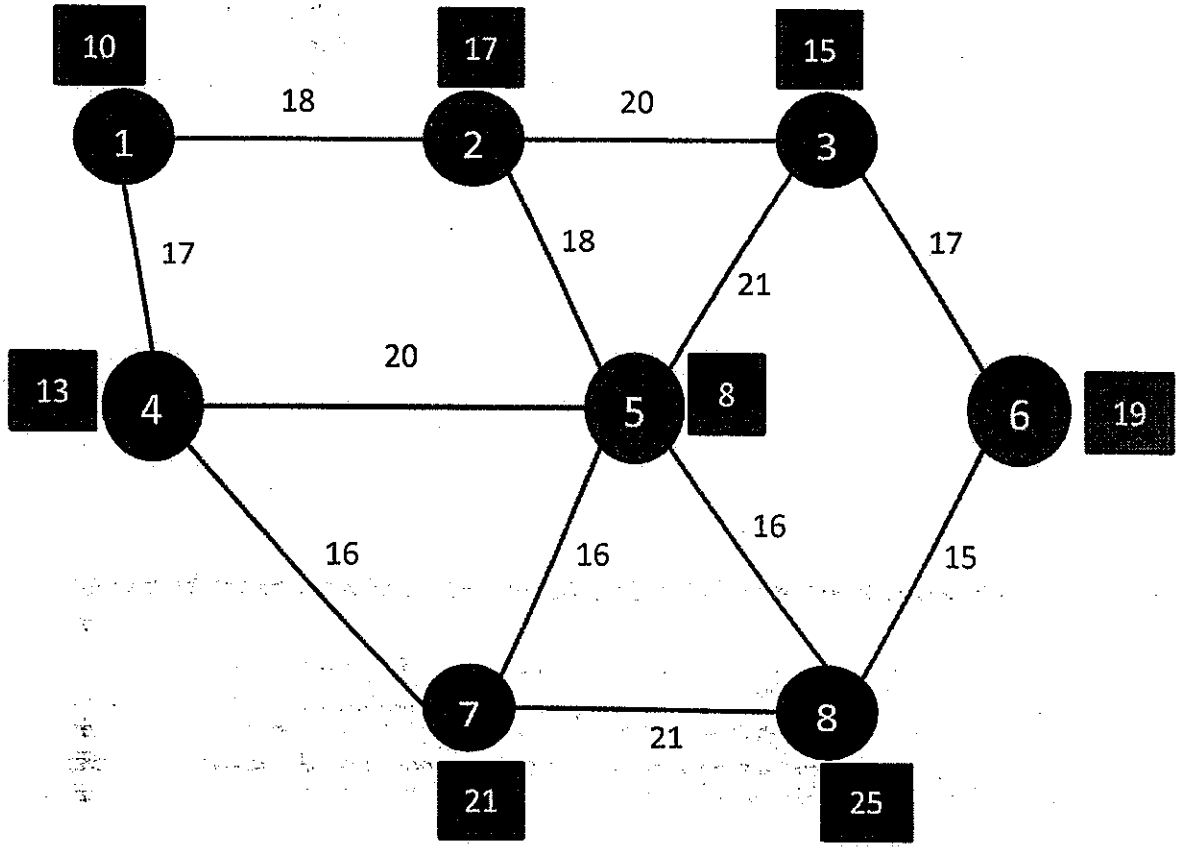

Figure 1

4 Ault Foods Limited is planning the production and distribution system for its new line of food products. Plants may be opened at any of sites $i = 1, \ldots, 7$, and warehouses at locations $j = 1, \ldots, 13$, to meet demand d_k (in thousands) at customer regions $k = 1, \ldots, 219$. Each plant costs \$50 million to open and produces up to 30 thousand cases per year. Each warehouse costs \$12 million to open and handles up to 10 thousand cases per year. Transportation costs are r_{ij} million per thousand cases for rail shipment from plant i to warehouse j, and t_{jk} million per thousand cases for trucking from warehouse j to customer k. No direct shipments from the plants are allowed. Formulate an optimization model to decide which facilities to open and how to serve customers using the following decision variables ($i = 1, \ldots, 7; j = 1, \ldots, 13; k = 1, \ldots, 219$):

x_{ijk} = thousand of cases produced at plant i and shipped to customer k via warehouse j,

$$y_i = \begin{cases} 1 & \text{if plant } i \text{ is open,} \\ 0 & \text{otherwise,} \end{cases}$$

$$w_j = \begin{cases} 1 & \text{if warehouse } j \text{ is open,} \\ 0 & \text{otherwise.} \end{cases}$$

(15 marks)

End of Paper

MP4F06 - Engineering Logistics

Nov/Dec 2013

A+

1) a)

Year	Sales (in $1000)	Birth (in thousands)
1	99	35
2	92	34
3	85	31
4	72	29
5	68	28

Exponential Smoothing ($\alpha = 0.25$) $\tau = 1$

A_t	F_t	$f_{t+\tau}$	Year
35	35		1
34	34.75	35	2
31	33.8125	34.75	3
29	32.61	33.8125	4
28	31.46	32.61	5
		31.46	6

$F_1 = A_1 = 35$

$F_2 = \alpha . A_2 + (1-\alpha) F_1$

$= (0.25)(34) + (0.75)(35)$

$= \boxed{34.75}$

The number of births in next year is $\boxed{31,460}$.

b) Let sales be x and birth be y. Use linear regression model.

x	y	x^2	$x.y$
99	35	9801	3465
92	34	8464	3128
85	31	7225	2635
72	29	5184	2088
68	28	4624	1904
Sum => 416	157	35,298	13,220

$$b_0 = \frac{\sum_{k=1}^{5} x_k^2 \sum_{k=1}^{5} y_k - \sum_{k=1}^{5} x_k \sum_{k=1}^{5} x_k y_k}{5 \sum_{k=1}^{5} x_k^2 - \left(\sum_{k=1}^{5} x_k\right)^2}$$

$$= \frac{(35,298)(157) - (416)(13,220)}{(5)(35,298) - (416)^2}$$

$$= \boxed{12.308}$$

$$b_1 = \frac{5 \sum_{k=1}^{5} x_k y_k - \sum_{k=1}^{5} x_k \sum_{k=1}^{5} y_k}{5 \sum_{k=1}^{5} x_k^2 - \left(\sum_{k=1}^{5} x_k\right)^2}$$

$$= \frac{(5)(13,220) - (416)(157)}{(5)(35,298) - (416)^2}$$

$$= \boxed{0.2295}$$

$\boxed{y = b_0 + b_1 x = 12.308 + 0.2295x}$

1) b) $y = 31.46$

$y = 12.308 + 0.2295x$

$x = \frac{(31.46 - 12.308)}{0.2295}$

$= \boxed{83.45}$

The sales of the baby food for next year is $\boxed{\$83,450}$

2) a) $F = 1000 + 10.Q$ dollar/order

$D = 750$ units/week

$= 39,000$ units/year

$C = 50$ dollar/unit

$r = 99$ dollar/unit

$h = 0.20$

$C(Q) = \left(\frac{D}{Q}\right) * F + \left(\frac{Q}{2}\right) * h * C$

$= \left(\frac{39,000}{Q}\right)(1000 + 10Q) + \left(\frac{Q}{2}\right)(0.20)(50)$

$= \frac{39 \times 10^6}{Q} + 390,000 + 5Q.$

$C'(Q) = -\frac{39 \times 10^6}{Q^2} + 5.$

$C'(Q) = 0$

$Q = 2,792.85 = \boxed{2,793 \text{ unit}}$

Total cost = 417,928.48 (shipping & inventory holding cost)

Unit cost = 1,950,000.00

b) $D = 600$ units/year

① $Q < 500$ $C = 0.3$ dollars/unit

② $500 \leq Q < 1000$ $C = 0.29$ dollars/unit

③ $Q \geq 1000$ $C = 0.28$ dollars/unit

$F = 8$ dollar/order

$h = 0.20$

For plan 1,

$Q^* = \sqrt{\frac{2.D.F}{h.C}} = \sqrt{\frac{(2)(600)(8)}{(0.20)(0.3)}} = \boxed{400}$

2) b) Total cost $C(Q) = \left(\frac{D}{Q}\right) \times F + \left(\frac{Q}{2}\right) \times h \times C + D \times C$

$= \left(\frac{600}{400}\right) \times 8 + \left(\frac{400}{2}\right) \times 0.20 \times 0.30 + 600 \times 0.3$

$= \boxed{\$204}$

For Plan 2,

$Q^* = \sqrt{\frac{2DF}{hC}} = \sqrt{\frac{(2)(600)(8)}{(0.20)(0.29)}} = 406.84 \simeq 407$

Since minimum is 500, $Q^* = 500$

$C(Q) = \left(\frac{D}{Q}\right) F + \left(\frac{Q}{2}\right) h.C + D.C$

$= \left(\frac{600}{500}\right) 8 + \left(\frac{500}{2}\right) (0.20)(0.29) + (600)(0.29)$

$= \boxed{\$198.10}$

For Plan 3,

$Q^* = \sqrt{\frac{2DF}{h.C}} = \sqrt{\frac{(2)(600)(8)}{(0.20)(0.28)}} = 414$

Since minimum is 1000, $Q^* = 1000$

$C(Q) = \left(\frac{D}{Q}\right) F + \left(\frac{Q}{2}\right) hC + D.C$

$= \left(\frac{600}{1000}\right) 8 + \left(\frac{1000}{2}\right) (0.20)(0.28) + (600)(0.28)$

$= \boxed{\$200.80}$

Plan	Q^*	$C(Q)$
1	400	\$204
2	500	\$198.10
3	1000	\$200.80

$\therefore$ Use plan 2 with $\boxed{Q^* = 500}$ and $C(Q)$ of \$198.10

2) c) $c = \$100$ dollars/unit

Service level type-I of 99%

Z-value = 2.33

$\mu = 800$ units/month

$\sigma = 100$ units/month

$L = 2$ weeks

$F = 500$ dollars/order

$h = 0.25$

Order time → ① monthly

② quarterly

1 month = 4 weeks

3 month = 1 quarter

4 quarter = 1 year

1 year = 48 weeks

① Replenish monthly

$\mu_{T+L} = (6/4)\,800 = 1200$

$\sigma^2_{T+L} = (6/4)\,100^2$

$\sigma_{T+L} = 122.47$

$S = (Z)(\sigma_{T+L}) + \mu_{T+L}$

$= (2.33)(122.47) + (1200)$

$= 1485.37 \approx \boxed{1486}$ units/month

$$\text{Total cost} = \left(\frac{\mu_T}{2} + (Z)(\sigma_{T+L})\right) \times h \times c + \frac{48}{T} \times F$$

$$= \left(\frac{800}{2} + (2.33)(122.47)\right)(0.25)(100) + \frac{48}{4} \times 500$$

$$= \boxed{23,133.88}$$

② Replenish quarterly

$\mu_{T+L} = (14/4)\,800 = 2800$ units/quarter

$\mu_T = (3)\,800 = 2400$ units/quarter

$\sigma_{T+L} = \sqrt{14/4}\,100 = 187.08$ units/quarter

$S = (Z)(\sigma_{T+L}) + \mu_{T+L} = (2.33)(187.08) + 2800 = 3,235.90 \approx \boxed{3236}$ units/quarter

$$\text{Total cost} = \left(\frac{\mu_T}{2} + (Z)(\sigma_{T+L})\right) \times h \times c + \frac{48}{T} \times F$$

$$= \left(\frac{2400}{2} + (2.33)(187.08)\right)(0.25)(100) + \frac{48}{12} \times 500$$

$$= \boxed{42,897.41}$$

Home Appliance should replenish inventory **monthly** as it is cheaper.

3) Use index i to index nodes.

P = number of facilities to be located.

Decision variables

$$y_i = \begin{cases} 1, & \text{if customer } i \text{ is covered} \\ 0, & \text{otherwise} \end{cases}$$

$$x_i = \begin{cases} 1, & \text{if facility } i \text{ is open} \\ 0, & \text{otherwise} \end{cases}$$

Model:

Max. $10y_1 + 17y_2 + 15y_3 + 13y_4 + 8y_5 + 19y_6 + 21y_7 + 25y_8$

s.t. $x_1 + x_2 + x_4 \geq y_1$

$x_1 + x_2 + x_5 \geq y_2$

$x_3 + x_6 \geq y_3$

$x_1 + x_4 + x_7 \geq y_4$

$x_2 + x_5 + x_7 + x_8 \geq y_5$

$x_3 + x_6 + x_8 \geq y_6$

$x_4 + x_5 + x_7 \geq y_7$

$x_5 + x_6 + x_8 \geq y_8$

$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 = P$

$y_i \in \{0, 1\}$ for $i = 1, 2, 3, 4, 5, 6, 7, 8$

$x_i \in \{0, 1\}$ for $i = 1, 2, 3, 4, 5, 6, 7, 8$

If coverage distance is 20,

max. $10y_1 + 17y_2 + 15y_3 + 13y_4 + 8y_5 + 19y_6 + 21y_7 + 25y_8$

s.t. $x_1 + x_2 + x_4 \geq y_1$

$x_1 + x_2 + x_3 + x_5 \geq y_2$

$x_2 + x_3 + x_6 \geq y_3$

$x_1 + x_4 + x_5 + x_7 \geq y_4$

$x_2 + x_4 + x_5 + x_7 + x_8 \geq y_5$

$x_3 + x_6 + x_8 \geq y_6$

$x_4 + x_5 + x_7 \geq y_7$

$x_5 + x_6 + x_8 \geq y_8$

$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 = P$

$y_i \in \{0, 1\}$ for $i = 1, 2, 3, 4, 5, 6, 7, 8$

$x_i \in \{0, 1\}$ for $i = 1, 2, 3, 4, 5, 6, 7, 8$

4) Plant $\longrightarrow$ Warehouse $\longrightarrow$ Customer

$j=1,\dots,7$ $\quad j=1,\dots,13$ $\quad k=1,\dots,219$

d_k = demand of customer at region k in thousand case

Fixed cost plant = \$50 million

Capacity of plant = 30 thousand case/year

Fixed cost warehouse = \$12 million

Capacity of warehouse = 10 thousand case/year

r_{ij} = Transportation cost from plant i to warehouse j in million dollar/thousand case

t_{jk} = Transportation cost from warehouse j to customer k in million dollar/thousand case

Decision variable:

x_{ijk} = thousand of cases produced at plant i and shipped to customer k via warehouse j

$$y_i = \begin{cases} 1, & \text{if plant } i \text{ is open} \\ 0, & \text{otherwise} \end{cases}$$

$$w_j = \begin{cases} 1, & \text{if warehouse } j \text{ is open} \\ 0, & \text{otherwise} \end{cases}$$

Model:

$$\min. \sum_{j=1}^{7} (50) y_i + \sum_{j=1}^{13} (12) w_j + \sum_{j=1}^{7}\sum_{j=1}^{13}\sum_{k=1}^{219} (r_{ij} + t_{jk}) x_{ijk}$$

s.t. $\sum_{j=1}^{13}\sum_{k=1}^{219} x_{ijk} \le (30) y_i$ for $i = 1, 2, 3, 4, 5, 6, 7$

$\sum_{i=1}^{7}\sum_{k=1}^{219} x_{ijk} \le (10) w_j$ for $j = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13$

$\sum_{i=1}^{7}\sum_{j=1}^{13} x_{ijk} = d_k$ for $k = 1, \dots, 219$

$y_i \in \{0, 1\}$ for $j = 1, \dots, 7$

$w_j \in \{0, 1\}$ for $j = 1, \dots, 13$

$x_{ijk} \ge 0$ for $j = 1, \dots, 7$; $j = 1, \dots, 13$; $k = 1, \dots, 219$

Good luck for your preparation and All the best !!!

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2016-2017

MA4850 – SUPPLY CHAIN AND LOGISTICS MANAGEMENT

April/May 2017 Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains **FIVE (5)** questions and comprises **FOUR (4)** pages.
2. Answer **ALL** questions.
3. Marks for each question are as indicated.
4. This is a **RESTRICTED OPEN-BOOK** examination (1 sheet of double-sided A4 reference paper is allowed).

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1. Farmer John needs to determine how many acres of apple and wheat to plant this year. An acre of apple trees yields 10 bushels of apples and requires 4 hours of labor per week. The apple can be sold at $6 a bushel. An acre of wheat yields 25 bushels of wheat and requires 10 hours of labor per week. The wheat can be sold at $4 a bushel. Seven acres of land and 40 hours per week of labor are available. The local government regulations require that at least 30 bushels of wheat must be produced during the current year. John's objective is to determine the numbers of acres for each of these two products in order to maximize the total revenue this year.

   (i) Define the decision variables and formulate this problem as a linear optimization model.

   (7 marks)

   (ii) Solve the linear optimization problem graphically.

   (13 marks)

2. Five workers in Company ABC are available to perform four tasks. The time that takes each worker to perform each task is given in Table 1. It is assumed that you are the supervisor at ABC and you need to assign workers to tasks in order to minimize the total time required to perform the four tasks.

Table 1

Worker	Task 1	Task 2	Task 3	Task 4
1	22	18	30	18
2	21	*M*	27	22
3	26	24	28	28
4	17	22	*M*	14
5	16	*M*	24	28

Note: "*M*" indicates that a worker cannot perform a particular task.

(i) Convert this problem into a balanced assignment problem.

(4 marks)

(ii) Solve this assignment problem by using the Hungarian method.

(13 marks)

3. The following data in Table 2 are the number of calculators sold at a bookshop over the past 8 weeks.

Table 2

Week	1	2	3	4	5	6	7	8
Sales	46	49	43	50	53	58	62	56

(i) Use a four-week moving average to forecast the sales for the weeks 6 to 8.

(6 marks)

(ii) Use the regression analysis method to forecast the sales for the weeks 6 to 8. (The first five weeks can be used as a baseline to estimate the regression parameters.)

(8 marks)

(iii) Evaluate the TWO forecasting methods by using the values of the mean squared error.

(6 marks)

4. An automotive company produces its new model in three manufacturing plants located in California, Mexico and Michigan. The car agents receive cars from the distribution centres located in Arizona, Iowa and South Carolina. The anticipated production over the next month (in 100s of cars) is 150 at California, 175 at Mexico and 275 at Michigan. Based on the sales records and other factors, the automotive company decided that the following numbers of cars (in 100s of cars) at the distribution centres at the month's end: 200 at Arizona, 100 at Iowa and 300 at South Carolina. The cost of shipping from each manufacturing plant to each distribution centre is given in Table 3 (in $1,000s)

Table 3

		To		
		Arizona	**Iowa**	**South Carolina**
From	**California**	6	8	10
	Mexico	7	11	11
	Michigan	4	5	12

(i) Is this an unbalanced transportation problem, explain why?

(4 marks)

(ii) Determine a pattern of shipping that minimizes the total transportation cost from the manufacturing plants to the distribution centres by using the greedy heustic.

(16 marks)

5. An oil refinery needs 816 barrels of a particular chemical annually. The chemical can be produced by the plant at a rate of 2000 barrels per year. It is estimated that the production set-up cost is $40, each barrel costs $10 to produce, and the holding cost is based on 40% annual interest rate.

(i) Determine the optimal size of a production run for this chemical.

(4 marks)

(ii) Determine the average annual cost of holding and set-up.

(3 marks)

(iii) If this particular chemical can be purchased from an external supplier with the following prices shown in Table 4, determine the optimal order quantity and total cost. Suppose that the ordering cost is $12.

Note: Question 5 continues on page 4.
Table 4 appears on page 4.

Table 4

Range (barrels)	Price ($)
1 to 100	20
101 to 200	18
201 or more	16

(12 marks)

(iv) Based on the cost information about this particular chemical, the oil refinery has to make a choice between manufacturing it in-house and purchasing it from an external supplier. Which is the better choice (determined the choice by the total cost calculations)?

(4 marks)

END OF PAPER

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2017-2018

MA4850 – SUPPLY CHAIN & LOGISTICS MANAGEMENT

November/December 2017 Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains **FIVE (5)** questions and comprises **FOUR (4)** pages.
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1. Table 1 shows the demand forecast of a product using Double Exponential Smoothing (DES), where the smoothing parameters for both the level estimate and the trend estimate are 0.3:

Table 1

Time period	Actual demand	Level Estimate	Trend Estimate	One-step forecast	Two-step forecast
1	211	211.00	0.00	-	-
2	214	211.90	0.27	211.00	-
3	243	221.42	3.04	212.17	211.00
4	233	227.02	3.81	224.46	212.44
5	248	235.99	5.36	230.84	227.51
6	246	242.74	5.78	241.34	234.65
7	264	253.16	7.17	248.52	246.70
8	261	260.53	7.23	260.33	254.29
9	260	265.43	6.53	267.76	267.50
10	264	**A**	**B**	271.97	274.99
11	275	275.27	5.78	**C**	278.50
12	270	277.74	4.78	281.05	**D**
13	268	278.17	3.48	282.52	286.83
14	298	286.55	4.95	281.64	287.31
15	302	294.65	5.89	291.50	285.12
16	299	300.08	5.76	300.54	296.45
17	289	300.79	4.24	305.84	306.44
18	303	304.42	4.06	305.03	311.59
19	295	304.43	2.85	308.48	309.27

Note: Question 1 continues on page 2.

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(a) Complete the empty cells in Table 1 marked by A, B, C, and D. Write down the steps of calculation.

(10 marks)

(b) Using the data for time periods from 15 to 19, compare the accuracy of the one-step and two-step forecasts based on Mean Absolute Deviation (MAD).

(10 marks)

2. A game developer has recently launched a new mobile game, which is very popular with college students. An analyst has collected the sales (y) data for the game in the past 5 months, as shown in Table 2. The analyst thinks sales are going up **exponentially** with respect to time (t) and wants to construct a model for sales forecast. Partial data analysis is provided in Table 2, where $\sum(\cdot)$ represents summation and $\sum(\cdot)^2$ represents summation of squares.

Table 2

	t	y	$ln(t)$	$ln(y)$
	1	50	0.0000	3.9120
	2	100	0.6931	4.6052
	3	400	1.0986	5.9915
	4	2,000	1.3863	7.6009
	5	20,000	1.6094	9.9035
$\sum(\cdot)$	15	22,550	4.79	32.01
$\sum(\cdot)^2$	55	404,172,500	6.20	228.26

Help the analyst to construct the model, and use the model to forecast the game sales for the next month, i.e. Month 6.

(20 marks)

Note: Question 3 appears on page 3.

3. A warehouse handles parcel deliveries for online retailers. The number of parcels received each day by the warehouse is a random variable with the following discrete probability distribution (Table 3). For example, there is a 2.5% probability for the number of parcels in a day to be 1500.

Table 3

Parcels	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
Probability	2.5%	5%	10%	20%	22.5%	15%	10%	7.5%	5%	2.5%

The warehouse employs a team of workers to deliver the parcels. Each worker can deliver 500 parcels per day, and costs the warehouse $300 to hire a worker for a day. In case the number of parcels exceeds the capacity of the workers, the warehouse would outsource delivery of the surplus parcels to a 3rd party logistics company, which charges $5 per parcel for the delivery service. Based on the information provided above, answer the questions below:

(a) What is the underage cost for the warehouse to NOT have enough workers?

(5 marks)

(b) What is the overage cost for the warehouse to have too many workers?

(5 marks)

(c) How many workers should the warehouse hire?

(10 marks)

4. A furniture store sells a particular brand of chairs in Singapore. The store buys the chairs from China via Alibaba, an e-commerce platform. The cost of the chair is $50 per unit, and the store sells it for $100 per unit. The demand for the chair at the furniture store is quite stable at 100 units per month. The annual inventory holding cost rate for the furniture store is 24%. Besides purchasing cost and inventory holding cost, the only other cost that is significant to the furniture store is shipping cost. *Note: the shipping cost is charged separately and is NOT part of the purchasing cost.*

(a) Suppose Alibaba charges a fixed fee of $800 for shipping, what will be the optimal order size for the furniture store?

(10 marks)

(b) Suppose Alibaba has a tiered fee structure for shipping, i.e. for any purchase order below $30,000, the shipping fee is $800 per order; for any purchase order between $30,000 and $50,000, the shipping fee is $500 per order; for purchase orders that are $50,000 or above, the shipping fee will be waived completely. What will be the optimal order size for the furniture store under this new fee structure?

(10 marks)

5. A fashion retailer in Singapore outsources the production of a special kind of handbags to a supplier in Vietnam. The retailer sets the retail price of the handbags at \$500/unit. At the end of the sales season, the retailer can salvage unsold handbags at \$50/unit. For the forthcoming sales season, the retailer anticipates 3 sales scenarios, namely *bad*, *average*, and *good*. The sales volume and probability of each scenario is given in Table 4.

Table 4

Scenario	Sales volume	Probability
Bad	300	30%
Average	500	45%
Good	800	25%

For the supplier, the fixed cost of production setup is \$20,000 and the variable cost of production is \$100/unit. Answer the following questions:

(a) What is the global optimal order quantity for the overall supply chain? And, what's the maximum total expected supply chain profit?

(7 marks)

(b) If the wholesale price the supplier charges the retailer is \$200/unit, what should be the retailer's order quantity? And, what is the expected profit for the retailer?

(8 marks)

(c) Suppose the only variable that the supplier and the retailer can negotiate in a supply contract is the wholesale price, what is the range of wholesale price on which both the supplier and the retailer will be profitable and maximum expected profit for the supply chain can be achieved?

(5 marks)

END OF PAPER

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2018-2019

MA4850 – SUPPLY CHAIN AND LOGISTICS MANAGEMENT

November/December 2018 Time Allowed: 2½ hours

INSTRUCTIONS

1. This paper contains **FIVE (5)** questions and comprises **THREE (3)** pages.
2. Answer **ALL** questions.
3. All questions carry equal marks.
4. This is a **RESTRICTED-OPEN BOOK** examination (1 sheet of double-sided A4 reference paper is allowed).

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1. Table 1 shows the sales of electric cars (in thousand units) and the average gasoline price in the past 3 years in an automobile market (year 3 is the most recent year).

Table 1

	Year		
	1	**2**	**3**
Sales ('000)	50	80	100
Gasoline price ($/gallon)	2.0	2.5	3.0

Based on the information provided, answer the following questions:

(a) Based on the time series data of sales in the past 3 years, use a single Exponential Smoothing method with $\alpha = 0.5$ to forecast the sales of electric cars in year 4.

(10 marks)

(b) It is estimated that the average gasoline price in year 4 will be 3.5 $/gallon. Suppose the sales of electric cars and average gasoline price are linearly related, develop a causal model to forecast the sales of electric cars in year 4.

(10 marks)

2. An electronics company manufactures a device in Singapore and sells it to South East Asian countries. The cost of the device is $10/unit. The demand for the device is steady at a rate of 500 units/month. On the production side, the setup cost for each production run is $2000. The rate of production is 2000 units/month. The inventory holding cost rate is 20% per year. Answer the following questions.

Note: Question 2 continues on page 2.

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(a) Determine the optimal size of each production run and the annual inventory related cost (including setup cost and inventory holding cost).

(10 marks)

(b) Suppose the time interval between production runs has to be multiples of 3 months, meaning that it could only be 3 months, 6 months, ..., etc., determine the optimal size of each production run with the additional information.

(10 marks)

3. A company based in Singapore is in the business of designing and selling scooters. The production of the scooters is outsourced to a supplier in China. The unit cost of a scooter is \$500. The monthly demand for the scooter follows a normal distribution with mean value of 500 units and standard deviation of 100 units. The company currently manages its inventory using a base stock policy, and replenishes its inventory every 6 weeks. The lead time of order delivery from its supplier is 3 weeks. The cost of placing an order is \$3000. The annual inventory holding cost rate is 20%. Note: conversions between time units are 1 year = 12 months = 48 weeks; the z value corresponding to 95% is 1.645.

(a) Under the base stock policy, what is the order-up-to level required to achieve a service level (Type 1) of 95%? And, what is the annual inventory related costs (including ordering cost and inventory holding cost)?

(10 marks)

(b) Help the company to design a (Q, R) policy to achieve a service level (Type 1) of 95%, and calculate the inventory related costs (including ordering cost and inventory holding cost).

(10 marks)

4. A start-up company has developed a new type of medical device. The company is negotiating a contract with a distributor for sales of the device. For the company, the fixed cost of production is \$50,000 and the variable cost of production is \$250/unit. The distributor is able to sell the medical device to hospitals at a price of \$800/unit. The demand for the medical device from hospitals is uncertain, with quantities and corresponding probabilities shown in Table 2 below. As the medical device is very specialized, the value of any leftovers is negligible, i.e. can be assumed to be 0.

Table 2

Demand (units)	**Probability**
300	20%
500	50%
800	30%

The company and the distributor have agreed upon a wholesale price of \$500/unit. The company is willing to buy back any leftover devices from the distributor at \$100/unit. Based on the information above, answer the following questions.

Note: Question 4 continues on page 3.

(a) How many medical devices should the distributor order from the company?
(10 marks)

(b) What are the expected profits for the company and the distributor, respectively?
(10 marks)

5. Figure 1 shows the battery architecture of Tesla Model S. The battery pack consists of 16 battery modules, each battery module consists of 444 Lithium ion battery cells, and each battery cell is measured by 18mm×65mm (diameter × height) in dimensions, hence called 18650 batteries. The production of the battery pack is highly automated. The battery cells are slotted into a case structure in an optimized array to make a battery module. The battery modules are then fitted into a battery pack that is sealed with high-strength steel panels. Each battery module has its own sensors for monitoring temperature, and battery modules are separated from each other with heat resistant materials in a battery pack that also serves as the floor of the car.

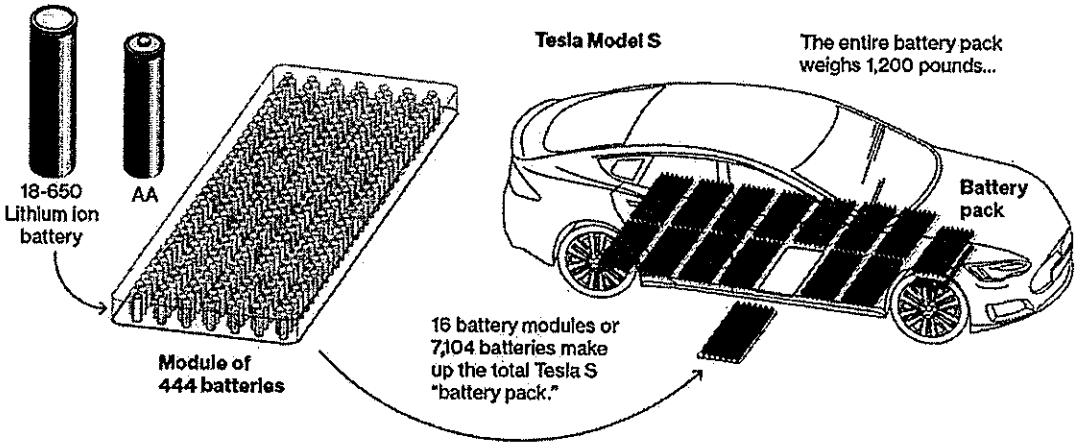

Figure 1

Discuss the characteristics of Tesla's battery architecture, and the implications on supply chain management in terms of key technological and economic advantages.
(20 marks)

END OF PAPER