优能教育
Excellence Private Tutoring

优能教育

2020 Semester 1

QBUS 2310 期末复习 刷题班

TUTOR: Joy

本课件及上课录屏录音材料仅供优能教育学员使用，任何第三方不应依赖本材料及相关视频，否则将承担因使用本材料而产生的任何风险。

1

优能教育
Excellence Private Tutoring

2

课程安排

每周知识点复习（共4节）：

~~Week1-3：week4~~

~~Week4-6：week7~~

~~Week8-10：week11~~

~~Week11-13：week13~~

讲解内容：知识点+题型练习+部分tutorial题目讲解

ASM题目练习及讲解：

- ASM1+2：往年2套ASM2题目练手讲解+今年ASM题目讲解提示

~~Online test~~题目讲解

考试复习：考试前1-2周内

- ~~期中考试：往年期中考试复习题+期中考试题~~
- ~~期中考试2：期中考试1中部分未讲解题目解析，期中复习题目问题汇总~~
- 期末考试：往年复习题+题型复习及练习，基础知识复习

QBUS2310 BY Joy

3

往年ASM2 讲解
第一套题目

Assignment 2	Oct 29, 2018 by 17:00	95.5	100

QBUS2310 BY Joy

4

Question 1 (15 marks): Use Excel for this question

An investor wants to invest $50,000 in two mutual funds, A and B. The rates of return, risks and minimum investment requirements for each fund are:

Fund	Rate of return	Risk	Minimum investment
A	12 %	0.5	$20,000
B	9 %	0.3	$10,000

Note that a low risk rating means a less risky investment. The investor wants to maximize the expected rate of return while minimizing his risk. Any money beyond the minimum investment requirements must be invested in one of the funds (all $50,000 have to be invested). Assume that the risk of a portfolio is equal to the weighted average of the risks of the individual funds.

5

a. Find the investment policy that maximizes return. What is the risk and return under this policy?

b. Find the investment policy that minimizes risk. What is the risk and return under this policy?

c. Formulate a goal programming model with a MINIMAX objective function. Assume that maximizing return and minimizing risk are equally important.

d. Solve the problem using EXCEL. Explain your result and provide a screenshot of your Excel sheet.

6

a. Find the investment policy that maximizes return. What is the risk and return under this policy?

Let X_1 = dollars in investment A
X_2 = dollars in investment B

In order to maximize return, solve the following LP:

$$Max\ 0.12x_1 + 0.09x_2$$
$$st.$$
$$x_1 + x_2 = 50{,}000$$
$$x_1 \geq 20{,}000$$
$$x_2 \geq 10{,}000$$
$$x_1, x_2 \geq 0$$

We obtain the following solution:

Fund	Rate of return	Risk	Minimum investment		amount invested		
A	12%	0.5	$20,000		40000	return	0.114
B	9%	0.3	$10,000		10000	risk	0.46
				Total	50000		
				RHS	50000		

QBUS2310 BY Joy

7

b. Find the investment policy that minimizes risk. What is the risk and return under this policy?

In order to minimize risk solve the following LP:

$$Min\ 0.5x_1 + 0.3x_2$$
$$st.$$
$$x_1 + x_2 = 50{,}000$$
$$x_1 \geq 20{,}000$$
$$x_2 \geq 10{,}000$$
$$x_1, x_2 \geq 0$$

We obtain the following solution:

Fund	Rate of return	Risk	Minimum investment		amount invested		
A	12%	0.5	$20,000		20000	return	0.102
B	9%	0.3	$10,000		30000	risk	0.38
				Total	50000		
				RHS	50000		

QBUS2310 BY Joy

8

c. Formulate a goal programming model with a MINIMAX objective function. Assume that maximizing return and minimizing risk are equally important.

The MOLP formulation is:

MINIMIZE Q
Subject to: $X_1 + X_2 = 50000$
$X_1 \geq 20000$
$X_2 \geq 10000$

$$\left(\frac{\left(0.114 - \frac{0.12X_1 + 0.09X_2}{50000}\right)}{0.114}\right) \leq Q$$

$$\left(\frac{\left(\frac{0.5X_1 + 0.3X_2}{50000}\right) - 0.32}{0.32}\right) \leq Q$$

$X_i \geq 0$ for all i, $Q \geq 0$

9

d. Solve the problem using EXCEL. Explain your result and provide a screenshot of your Excel sheet.

Using Excel we obtain the following solution:

Fund	Rate of return	Risk	Minimum investment		amount invested		Actual	Target	% deviation	objective Q
A	12%	0.5	$20,000		26666.6667	return	0.106	0.114	7.02%	7.02%
B	9%	0.3	$10,000		23333.3333	risk	0.40666667	0.38	7.02%	
				Total	50000					
				RHS	50000					

The optimal solution consists of investing 26,667 dollars in Fund A and the remaining 23,333 dollars in Fund B. The percentage deviation from the best possible solution for each objective is 7.02%.

10

Question 2 (25 marks): Use Python for this question

You have been put in charge of training new employees (trainees) at a commercial bank. In order to fill the role of an investment consultant each trainee must successfully complete a sub-set of 6 available courses (A, B, C, D, E, F). There are four different sequences of courses that can be taken in order to achieve the required skill level. These sequences are A-E, B, C-F, and A-D-F. The table below provides information on the six courses.

Course	Cost Per Trainee	Min. Num. of Trainees	Max. Num. of Trainees
A	25	15	40
B	55	10	50
C	30	15	50
D	10	15	50
E	20	10	50
F	15	10	50

There are 100 new trainees available for training and a demand for 100 skilled investment consultants. Assume all employees (trainees) pass each course they are allocated to and that you are trying to assign trainees to classes in order to minimize the total cost of training. Assume each course will be held.

QBUS2310 BY Joy

11

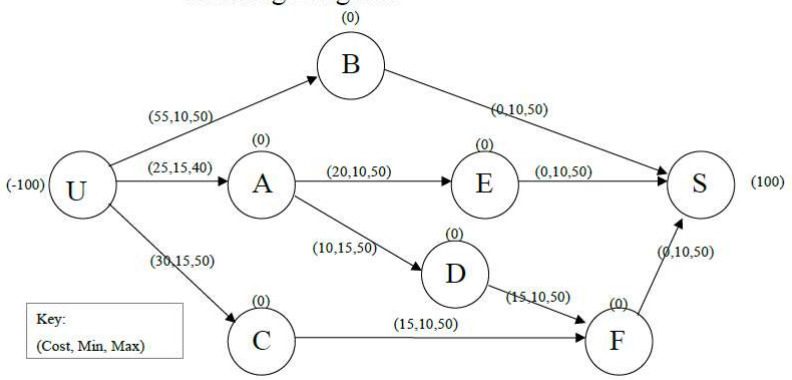
In addition to the formulation, solution and Python output you should provide the network flow diagram describing the problem and address the following questions:

What is the expected student load for each course?
Should any course be expanded?
Should any course or sequence be considered for elimination?

QBUS2310 BY Joy

12

Training Diagram



13

Let U be a source of unskilled employees.
Let S be a destination of skilled investment consultants.
Let A, B, C, D, E and F, be courses.

Decision Variables: Let X_{ij} be the network flow between nodes i and j.

Formulation:

Minimize $25\ X_{UA} + 55\ X_{UB} + 30\ X_{UC} + 10\ X_{AD} + 20\ X_{AE} + 15\ X_{CF} + 15\ X_{DF}$

14

Formulation:

Minimize $25 X_{UA} + 55 X_{UB} + 30 X_{UC} + 10 X_{AD} + 20 X_{AE} + 15 X_{CF} + 15 X_{DF}$

Subject to:

$- X_{UA} - X_{UB} - X_{UC} = -100$
$X_{UA} - X_{AE} - X_{AD} = 0$
$X_{UB} - X_{BS} = 0$
$X_{UC} - X_{CF} = 0$
$X_{AD} - X_{DF} = 0$
$X_{AE} - X_{ES} = 0$
$X_{CF} + X_{DF} - X_{FS} = 0$
$X_{BS} + X_{ES} + X_{FS} = 100$
$15 \leq X_{UA} \leq 40$
$10 \leq X_{UB} \leq 50$
$15 \leq X_{UC} \leq 50$
$10 \leq X_{AE} \leq 50$
$15 \leq X_{AD} \leq 50$
$10 \leq X_{BS} \leq 50$
$10 \leq X_{CF} \leq 50$
$10 \leq X_{DF} \leq 50$
$10 \leq X_{ES} \leq 50$
$10 \leq X_{FS} \leq 50$

QBUS2310 BY Joy

15

Load for each course:

A – 40	D – 15
B – 25	E - 25
C – 35	F – 50

Total cost of training:

4,825 dollars.

Should any course be expanded?

Courses A and F are running at capacity

Should any course or sequence be considered for elimination?

Sequence A-D-F. Course D is at a minimum level. This minimum forces underutilization of course B.

Investment consultant training

ship	from		to		unit cost	Min class	Max class
40	1	U	2	course A	$25	15	40
25	1	U	3	course B	$55	10	50
35	1	U	4	course C	$30	15	50
15	2	course A	5	course D	$10	15	50
25	2	course A	6	course E	$20	10	50
25	3	course B	8	S	$0	10	50
35	4	course C	7	course F	$15	10	50
15	5	course D	7	course F	$15	10	50
25	6	course E	8	S	$0	10	50
50	7	course F	8	S	$0	10	50

Total training cost $4,825.00

Nodes		net flow	supply/den
1	U	-100	-100
2	course A	-1E-06	0
3	course B	0	0
4	course C	0	0
5	course D	0	0
6	course E	0	0
7	course F	0	0
8	S	100	100

QBUS2310 BY Joy

16

Question 3 (30 marks):

Linda has decided to renovate her old shop. She has identified the following activities that must be performed before she can reopen for business:

Activity	Description	Duration (in days)	Predecessor activities
A	New Plumbing	10	--
B	Order/Rec Furniture	20	--
C	Order/Rec Flooring	15	--
D	Construct Partitions	5	--
E	Paint & Wallpaper	5	A, D
F	Install Furniture	3	E, B
G	Install Flooring	4	E, C
H	Move Inventory & Rec's	2	F, G
I	Clean Old Shop	2	H

17

a. **Draw** the activity network for this problem (AON).

b. Provide the earliest and latest start and finish times, the slack for each activity, and identify the critical activities (either on the network or in a table).

c. What is the duration of the project? Provide the critical paths(s).

18

d. Suppose that Linda has a binding contract stating that she must complete the renovation within 20 days. The normal and crash times and costs for each activity are summarized in the table below. Is it possible for her to complete the project within 20 days? If it is possible, at what cost? If it is not possible, what is the earliest time she can complete the project and at what cost?

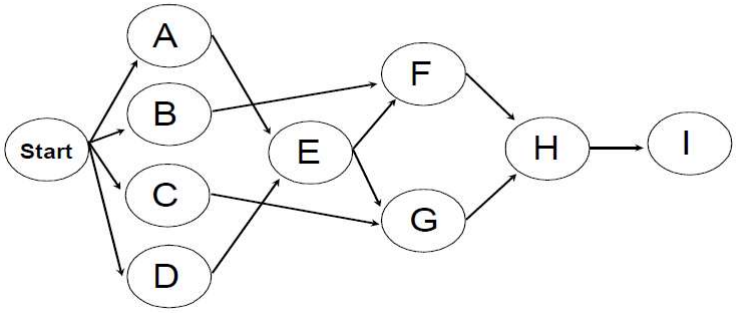
Activity	Normal		Crash	
	Time (days)	Cost (dollars)	Time (days)	Cost (dollars)
A	10	11,000	7	15,000
B	20	5,000	18	6,000
C	15	3,000	12	3,500
D	5	1,500	3	2,000
E	5	750	2	1,200
F	3	600	1	1,200
G	4	1,000	2	1,500
H	2	250	1	450
I	2	200	1	300

QBUS2310 BY Joy

19

a. **Draw** the activity network for this problem (AON).

The AON network describing the project is:



QBUS2310 BY Joy

20

Activity	Description	Days	EST	EFT	LST	LFT	Slack	
Start	dummy activity	0	0	0	0	0	0	**
A	New Plumbing	10	0	10	4	14	4	
B	Ordr/Rec Furniture	20	0	20	0	20	0	**
C	Ordr/Rec Flooring	15	0	15	4	19	4	
D	Construct Partitions	5	0	5	9	14	9	
E	Paint & Wallpaper	5	10	15	14	19	4	
F	Install Furniture	3	20	23	20	23	0	**
G	Install Flooring	4	15	19	19	23	4	
H	Move Inventory & Rec's	2	23	25	23	25	0	**
I	Clean Old Shop	2	25	27	25	27	0	**

Note: "**" denotes critical activities

21

c. What is the duration of the project? Provide the critical paths(s).

The duration of the project is 27 days.
The critical path consists of the sequence of activities B-F-H-I (note that "Start" is not included as it is a "dummy" activity).

22

There is no feasible crash schedule that will allow Linda to complete her move within 20 days. If the crash times cannot be reduced further, the best she can do is complete the move in 21 days. The least costly way of completing the move within 21 days is shown below.

PATH		I(100)	H(200)	F(300)	F(300)	B(500)	B(500)
AEGHI	23	22	21	21	21	21	21
BFHI	27	26	25	24	23	22	21
CGHI	23	22	21	21	21	21	21
DEFHI	17	16	15	14	13	13	13
DEGHI	18	17	16	16	16	16	16

After having invested $1,900 we have 3 critical paths requiring 21 days for completion. Since we cannot shorten any activity on path BFHI we cannot complete the project in 20 days.

23

Question 4 (30 marks): Use Python for this question

A tour bus company has to decide on the number of small, medium and large buses it will operate during the next tourist season. The company would like to restrict the size of its fleet to 80 buses and ensure that at least 10% of its buses are large (this is a legal requirement since the company must have at least 10% of its fleet accessible to wheelchairs, and only the large buses meet this standard). The number of seats on small, medium and large buses is 30, 40 and 50, respectively. The company wants to ensure that it can accommodate at least 3,000 passengers at any given time.

In the following table, the daily cost (in dollars), the pollution rating and the safety rating of the three bus types is given. The pollution rating is on a scale of 1 to 10 where 1 reflects the lowest levels of pollution and 10 reflects the least environmentally friendly score. The safety rating is also on a scale of 1 to 10 with 10 being the score for the safest bus.

Bus	Cost per day	Pollution rating	Safety score
Large	$490	8	9
Medium	$440	5	8
Small	$400	7	6

24

a. Find the bus fleet that minimizes costs. What is the cost, the mean pollution rating and the mean safety score for this fleet?

b. Find the bus fleet that minimizes the mean pollution rating. What is the cost, the mean pollution rating and the mean safety score for this fleet?

c. Find the bus fleet that maximizes the mean safety. What is the cost, the mean pollution rating and the mean safety score for this fleet?

d. Formulate a goal programming model with a MINIMAX objective function. Assume that safety is twice as important as both costs and pollution.

e. Solve problem (d) using Python. Explain your result and provide a screenshot of your code.

25

a. Find the bus fleet that minimizes costs. What is the cost, the mean pollution rating and the mean safety score for this fleet?

Let X_1 = number of large buses
X_2 = number of medium buses
X_3 = number of small buses

In order to minimize total cost, solve the following LP:

$$Min\ 490x_1 + 440x_2 + 400x_3$$
$$st.$$
$$x_1 + x_2 + x_3 \leq 80 \quad \text{(fleet size)}$$
$$50x_1 + 40x_2 + 30x_3 \geq 3000 \quad \text{(capacity)}$$
$$x_1 \geq 0.1(x_1 + x_2 + x_3) \quad \text{(10\% large buses)}$$
$$x_1, x_2, x_3 \geq 0 \quad (non\ negativity)$$
$$x_1, x_2, x_3\ integer$$

26

The cost, total pollution and total safety are given in the solution below:

X1	X2	X3
60	0	0

				LHS	RHS	
parking spots	1	1	1	60	80	<
capacity	50	40	30	3000	3000	>
contract	0.9	-0.1	-0.1	54	0	>

cost	490	440	400	29400
pollution	8	5	7	480
safety	9	8	6	540

27

b. Find the bus fleet that minimizes the total pollution rating. What is the cost, the mean pollution rating and the mean safety score for this fleet?

In order to minimize total pollution, solve the following LP:

$$Min\ 8x_1 + 5x_2 + 7x_3$$
$$st.$$
$$x_1 + x_2 + x_3 \leq 80 \quad \text{(fleet size)}$$
$$50x_1 + 40x_2 + 30x_3 \geq 3000 \quad \text{(capacity)}$$
$$x_1 \geq 0.1(x_1 + x_2 + x_3) \quad \text{(10\% large buses)}$$
$$x_1, x_2, x_3 \geq 0 \quad (non\ negativity)$$
$$x_1, x_2, x_3\ integer$$

The cost, total pollution and total safety are given in the solution below:

28

	X1	X2	X3
	8	65	0

				LHS	RHS	
parking spots	1	1	1	73	80	<
capacity	50	40	30	3000	3000	>
contract	0.9	-0.1	-0.1	0.7	0	>

cost	490	440	400	32520
pollution	8	5	7	389
safety	9	8	6	592

29

c. Find the bus fleet that maximizes the mean safety. What is the cost, the mean pollution rating and the mean safety score for this fleet?

In order to maximize total safety, solve the following LP:

$$
\begin{aligned}
&Max\ 9x_1 + 8x_2 + 6x_3 \\
&\quad st. \\
&x_1 + x_2 + x_3 \le 80 \quad \text{(fleet size)} \\
&50x_1 + 40x_2 + 30x_3 \ge 3000 \quad \text{(capacity)} \\
&x_1 \ge 0.1(x_1 + x_2 + x_3) \quad \text{(10\% large buses)} \\
&x_1, x_2, x_3 \ge 0 \quad (non\ negativity) \\
&x_1, x_2, x_3\ integer
\end{aligned}
$$

The cost, total pollution and total safety are given in the solution below:

30

X1	X2	X3
80	0	0

				LHS	RHS
parking spots	1	1	1	80	80<
capacity	50	40	30	4000	3000>
contract	0.9	-0.1	-0.1	72	0>

cost	490	440	400	39200
pollution	8	5	7	640
safety	9	8	6	720

31

Formulate a goal programming model with a MINIMAX objective function. Assume that safety is twice as important as both costs and pollution.

In order to find the optimal solution, we solve the following LP:

$$Min\ Q$$
$$st.$$
$$Q \geq \left(\frac{(490x_1 + 440x_2 + 400x_3) - 29400}{29400}\right)$$
$$Q \geq \left(\frac{(8x_1 + 5x_2 + 7x_3) - 381}{381}\right)$$
$$Q \geq 2\left(\frac{652 - (9x_1 + 8x_2 + 6x_3)}{652}\right)$$
$$x_1 + x_2 + x_3 \leq 80$$
$$50x_1 + 40x_2 + 30x_3 \geq 3000$$
$$x_1 \geq 0.1(x_1 + x_2 + x_3)$$
$$x_1, x_2, x_3 \geq 0$$
$$x_1, x_2, x_3\ integer$$

32

往年ASM2 讲解
第二套题目

Assignment 2	Nov 4, 2019 by 23:59	91.5	100

33

Question 1 (40 marks)

The Professor you met in the Mid Semester Exam has decided to delay her retirement and now plans to work for up to another 10 years (boy she really must like teaching!), although the exact date of her retirement is somewhat dependent of the success of her investment strategy, which involves investing in a combination of the following five funds.

Investment Fund	% Return (over the period)	Risk Index (points)	Maturity (years)
Capital Guaranteed Fund	6%	7	3
Australian Bonds Fund	7%	4	9
Australian Equities	8%	6	5
Sustainable Growth Fund	9%	5	4
International Equities	11%	9	10

34

Obviously, she would like to maximise her return while minimising both her level of risk and the time to maturity (maybe she is not as enamoured with her students as we first thought?). Specifically, her objectives are that her overall return must exceed 7.2%, while both the risk level and time to maturity can't exceed 7.5 points and 7.5 years respectively. She has $500,000 in superannuation savings and plans to invest **all** her money.

a) Formulate a MOLP model for the Professor's problem. Determine the best outcome for each of her 3 objectives and set appropriate goals. Marks will be deducted if the mathematical formulation isn't supported with a written explanation. (24 marks, 12 for formulation and 12 for 3 sets of python code)

b) Assuming the Professor wishes to minimise the sum of percentage deviations from all three goals, what is her optimal investment strategy? (6 marks, 3 for formulation and 3 for python code)

c) Use the Minmax function to determine the Professor's optimal investment policy if maximising returns is twice as important as minimising risk and years to maturity. (10 marks, 5 for formulation and 5 for python code)

35

Since all the money will be invested according to the question, the weight of the money is more important than the actual amount of the money, so the decision variables can be the weight of the money invested in each fund:

X1: the weight of the money invested in the Capital Guaranteed Fund.

X2: the weight of the money invested in the Australian Bonds Fund.

X3: the weight of the money invested in the Australian Equities.

X4: the weight of the money invested in the Sustainable Growth Fund.

X5: the weight of the money invested in the International Equities.

(2) Defining the objective function.

There are three objectives based on the question:

Max 0.06X1+0.07X2+0.08X3+0.09X4+0.11X5 (Maximising the return rate)

Min 7X1+4X2+6X3+5X4+9X5 (Minimising the overall risk index)

Min 3X1+9X2+5X3+4X4+10X5 (Minimising the overall maturity)

36

(3) Defining the constraints.
The return constraint:
0.06X1+0.07X2+0.08X3+0.09X4+0.11X5 > 0.072 (the overall return must exceed 7.2%)

The risk constraint:
7X1+4X2+6X3+5X4+9X5 <= 7.5 (the overall risk index cannot exceed 7.5)

The maturity constraint:
3X1+9X2+5X3+4X4+10X5 <= 7.5 ((the overall time to maturity cannot exceed 7.5)

Non-negativity:
Xi >= 0 for i = 1,2,3,4,5

The weight constraint:
X1+X2+X3+X4+X5=1

QBUS2310 BY Joy

37

(4) Defining the goals:

Since we have three objectives, it is hard to perfectly satisfy all the objectives, setting goals is needed for the further calculation. These goals can be solved by solving 3 LP problems about different objectives separately.

The goal of return:

Holding the decision variables and constraints the same, and the objective is

Max 0.06X1+0.07X2+0.08X3+0.09X4+0.11X5 (Maximising the return rate), Then the goal is calculated by python:

As the result, the optimal objective value of maximizing the return rale is 0.1017.

so, the goal of the return: The return rate should be approximately 0.1017.

The goal of risk:

Holding the decision variables and constraints the same, and the objective is

Min 7X1+4X2+6X3+5X4+9X5 (Minimising the overall risk index), Then the goal is calculated by python:

As the result, the optimal objective value of minimising the risk index is 4.3.

so, the goal of the risk: The risk index should be approximately 4.3.

QBUS2310 BY Joy

38

The goal of risk:

Holding the decision variables and constraints the same, and the objective is

Min 3X1+9X2+5X3+4X4+10X5 (Minimising the overall maturity) Then the goal is calculated by python:

As the result, the optimal objective value of minimising the risk index is 3.4.

so, the goal of the risk: The risk index should be approximately 3.4.

Put all the goals together:

the goal of the return: The return rate should be approximately 0.1017.

the goal of the risk: The risk index should be approximately 4.3.

the goal of the risk: The risk index should be approximately 3.4.

39

Part B Minimising the sum of percentage deviations from all three goals

Here, an assumption is made: these three objectives have equal weight (w1=w2=w3=1), and three deviational variables is introduced as:

d1: the amount by which the goal of the return rate is underachieved. (The goal cannot be overachieved because the goal itself has already been the maximum value)

d2: the amount by which the goal of the risk index is exceed. (The goal cannot be underachieved because the goal itself has already been the minimum value)

d3: the amount by which the goal of the time to maturity is exceed. (The goal cannot be underachieved because the goal itself has already been the minimum value)

Based on that:

d1 = 0.1017-0.06X1-0.07X2-0.08X3-0.09X4-0.11X5

d2 = 7X1+4X2+6X3+5X4+9X5-4.3

d3 = 3X1+9X2+5X3+4X4+10X5-3.4

The objective is:

Min d1/0.1017 + d2/4.3+ d3/3.4

40

Constraints:

The return constraint:

0.06X1+0.07X2+0.08X3+0.09X4+0.11X5 >= 0.072 (the overall return must exceed 7.2%)

The risk constraint:

7X1+4X2+6X3+5X4+9X5 <= 7.5 (the overall risk index cannot exceed 7.5)

The maturity constraint:

3X1+9X2+5X3+4X4+10X5 <= 7.5 ((the overall time to maturity cannot exceed 7.5)

Non-negativity:

Xi >= 0 for i = 1,2,3,4,5

The weight constraint:

X1+X2+X3+X4+X5=1

Link constraints:

0.06X1+0.07X2+0.08X3+0.09X4+0.11X5+d1= 0.1017

7X1+4X2+6X3+5X4+9X5 = 4.3

3X1+9X2+5X3+4X4+10X5-d3=3.4

QBUS2310 BY Joy

41

Part C Using Minmax Function

In this part, the weight of the objectives is given as w1=2, w2=w3=1, thus, the return goal is twice more important than the risk goal and the time to maturity goal. By using the Minmax function, besides the decision variables introduced before, a new decision variable, Q, needs to be introduced for minimising the maximum deviation of goals.

The objective now is changed to: Min Q (Minimising the value of Q)

The return constraint:

0.06X1+0.07X2+0.08X3+0.09X4+0.11X5 >= 0.072 (the overall return must exceed 7.2%)

The risk constraint:

7X1+4X2+6X3+5X4+9X5 <= 7.5 (the overall risk index cannot exceed 7.5)

The maturity constraint:

3X1+9X2+5X3+4X4+10X5 <= 7.5 ((the overall time to maturity cannot exceed 7.5)

Non-negativity:

Xi >= 0 for i = 1,2,3,4,5

The weight constraint:

X1+X2+X3+X4+X5=1

Link constraints:

0.06X1+0.07X2+0.08X3+0.09X4+0.11X5+d1= 0.1017

7X1+4X2+6X3+5X4+9X5 = 4.3

3X1+9X2+5X3+4X4+10X5-d3=3.4

And additional constraints:

2d1/0.1017<=Q

d2/4.3<=Q

d3/3.4<=Q

QBUS2310 BY Joy

42

Question 2 (30 marks)

Sea Swift Shipping operates a weekly cargo run between Darwin and the Tiwi Islands. Sitting on the docks in Darwin are the following consignments from four different customers, who want to transport their cargoes to Melville Island on the next available sailing.

	Consignment Details		
Customer	Tonnage	Volume per ton (m3)	Profit per ton ($)
1. Clearwater Island Lodge	18	4.5	$ 64.00
2. N.T. Land Council	48	4.0	$ 56.00
3. Pluto Mining	15	3.0	$ 48.00
4. Tiwi Timber	30	2.5	$ 40.00

While there are overall tonnage and volume restrictions that must be adhered to, the load master must also ensure that the load is balanced across the vessel's three cargo holds. The weight of cargo in the bow (forward) hold must be within -/+10% of the weight of cargo in the stern (rear) hold. Additionally, the weight of cargo contained in the centre hold must be between 40 – 60% of the total weight of the shipment. While the load master can stow any combination of cargoes, any one hold can only take the cargo from one customer.

43

	Capacity	
Hold	Tonnage	Volume (m3)
Bow	32	180
Centre	58	210
Stern	40	160

The load master task is to decide on the load combination that will maximise Sea Swift's profits.

a) Formulate an Integer Linear Program model for this problem. Marks will be deducted if the mathematical formulation isn't supported with a written explanation. (20 marks)

b) Create an Excel model to solve the formulation. What is the optimal strategy? Include a screenshot of your Excel model (6 marks, 8 marks for the Excel model, 4 marks for the optimal strategy)

44

Here, we need to decide if we accept the customers consignments, if we do, how many can we take, and which hold will used for them. Based on that, the decision variables should be:

Xij: The tonnage of consignments of customers in each hold.

Bij: If we choose to put different consignments into different holds. (Binary variables)

(2) Defining the objective:

Since we want to maximize the total profit:

Total profit = Tonnage of each consignments*profit per ton of each consignments

Max:64 (X11+X12+X13) +56(X21+X22+X23) +48(X31+X32+X33) +40(X41+X42+X43)

QBUS2310 BY Joy

45

Consignments constraints:

X11+X12+X13<= 18

X21+X22+X23<=48

X31+X32+X33<=15

X41+X42+X43<=30

Link constraints

X1j <= 18B1j

X2j <= 48B2j

X3j <= 15B3j

X4j <= 30B4j

Tonnage limitation:

X11+X21+X31+X41<=32

X12+X22+X32+X42<=58

X13+X23+X33+X43<=40

Volume Limitation:

4.5X11+4X21+3X31+2.5X41<=180

4.5X12+4X22+3X32+2.5X42<=210

4.5X13+4X23+3X33+2.5X43<=160

Balance Constraints:

0.9 (X13+X23+X33+X43) <= X11+X21+X31+X41<=1.1 (X13+X23+X33+X43)

X12+X22+X32+X42>=0.4(X11+X21+X31+X41+X12+X22+X32+X42+X13+X23+X33+X43)

X12+X22+X32+X42<=0.6(X11+X21+X31+X41+X12+X22+X32+X42+X13+X23+X33+X43)

Other constraints (any one hold can only take the cargo from one customer)

B11+B21+B31+B41<=1

B12+B22+B32+B42<=1

B13+B23+B33+B43<=1

B13+B23+B33+B43<=1

QBUS2310 BY Joy

46

D21 | 20

	A	B	C	D	E	F	G	H	I	J	K
1	Customer	Tonnage	Volume/ton	profit per ton	total profit						
2	1	18	4.5	64	1152						
3	2	48	4	56	2688						
4	3	15	3	48	720						
5	4	30	5	40	1200						
6											
7	Decision variables						Constraints (volume)				
8	binary						Customer/l	bow	centre	stern	
9	Customer/helds	bow	centre	stern			1	81	0	0	
10	1	1	0	0			2	0	192	0	
11	2	0	1	0			3	0	0	0	
12	3	0	0	0			4	0	8.88E-15	100	
13	4	0	0	1							
14	Total	1	1	1			total volum	81	192	100	
15	limitaion	1	1	1			limitation	180	210	160	
16											
17	Customer/helds	bow	centre	stern	total		Link				
18	1	18	0	0	18		Customer/l	bow	centre	stern	
19	2	0	48	0	48		1	18	0	0	
20	3	0	0	0	0		2	0	48	0	
21	4	0	1.776E-15	20	20		3	0	0	0	
22	Total tonnage	18	48	20	86		4	0	0	30	
23	Limitation	32	58	40							
24	Maximize profit	4640									

Based on the solution of the excel, the optimal strategy is that:

18 tons of consignments of customer 1 is assigned into Bow

48 tons of consignments of customer 2 is assigned into centre

20 tons of consignments of customer 3 is assigned into stern

QBUS2310 BY Joy

47

优能教育 Excellence Private Tutoring

Question 3 (30 marks)

An electrical wholesaler has three distribution centres in Sydney, located in the suburbs of Wetherill Park, Chipping Norton and Casula. They also have three major customers, who have facilities located in Penrith, Bankstown and Northmead.

The following matrix sets out supply and demand volumes (# of pallets of product) as well as the per pallet transportation costs for each distribution centre-customer pair. With respect to supply, each distribution centre carries 50 pallets of safety stock, over and above the amount shown in the matrix which they can use to increase supply if required.

	Distribution Centres			
Customer Facility	1. Wetherill Park	2. Chipping Norton	3. Casula	**Demand**
1. Penrith	32	50	36	200
2. Bankstown	40	40	60	300
3. Northmead	56	70	34	500
Supply	200	300	400	

QBUS2310 BY Joy

48

The wholesaler has the following goals:

As much as possible, it would like to satisfy its customers' demand, while at the same time using as much of its own supply as possible. It also has a goal of keeping delivery costs as near to $58,000 as possible.

a) Formulate a goal programming model for this problem assuming the wholesaler wishes to minimise the sum of percentage deviations from its goals. Marks will be deducted if the mathematical formulation isn't supported with a written explanation. (20 marks).

b) Solve this problem using python and state the solution. A screenshot of the Python code **must** be included in your assignment and the python file should be submitted separately. Please note a minimum of 50% of marks will be deducted where the formulation and the python code are different. (8 marks)

c) How does the solution change if the company wishes to reduce the transportation cost goal by 50%? Comment on your findings. (It is **not** necessary to provide a screenshot of the new python code) (2 marks)

49

(1) Defining the decision variables

Here, we want to know the number of pallets of product transferred to each customer from each supplier. Based on that:

Xij: the amount of product transferred to customer i from supplier j.

X11: the amount of product transferred to custom

X12: the amount of product transferred to custom

X13: the amount of product transferred to custom

Rebecca Chan

be specific

X21: the amount of product transferred to customer 2 from supplier 1.

X22: the amount of product transferred to customer 2 from supplier 2

X23: the amount of product transferred to customer 2 from supplier 3.

X31: the amount of product transferred to customer 2 from supplier 1.

X32: the amount of product transferred to customer 2 from supplier 2

X33: the amount of product transferred to customer 2 from supplier 3.

50

Since it is hard to perfectly satisfy all the three goals, deviational variables are needed:

Here, an assumption is needed that the customers will not accept any product that exceed their demand. (The goal of customer demand cannot be overachieved.)

The deviational variables are:

d1: the amount by which the goal of the customer 1's demand is underachieved.

d2: the amount by which the goal of the customer 2's demand is underachieved.

d3: the amount by which the goal of the customer 3's demand is underachieved.

d4: the amount by which the goal of the supplier 1's supply is underachieved.

d5: the amount by which the goal of the supplier 1's supply is overachieved.

d6: the amount by which the goal of the supplier 2's supply is underachieved.

d7: the amount by which the goal of the supplier 2's supply is overachieved.

d8: the amount by which the goal of the supplier 3's supply is underachieved.

d9: the amount by which the goal of the supplier 3's supply is overachieved.

d10: amount by which the goal of the supply is underachieved.

d11: amount by which the goal of the cost is overachieved.

QBUS2310 BY Joy

51

(2) Defining the goals:

As talked before, the goals in this case are:

The product transferred to customer 1should be approximately 200

The product transferred to customer 2 should be approximately 300

The product transferred to customer 2 should be approximately 500

The product transferred from supplier 1 should be approximately 200

The product transferred from supplier 2 should be approximately 300

The product transferred from supplier 3 should be approximately 400

The total delivery cost should be approximately 58,000

QBUS2310 BY Joy

52

(3) Defining the objective

Here, we assume that these three goals are equally important. (w1=w2=w3=1)

Since we want to minimise the sum of percentage deviations, the objective is:

Min:
d1/200+d2/300+d3/500+(d4+d5)/200+(d6+d7)/300+(d8+d9)/500+(d10+d11)/58000

Goal constraints:

X11+X12+X13+d1= 200

X21+X22+X23+d2= 300

X31+X32+X33+d3= 500

X11+X21+X31+d4-d5= 200

X12+X22+X32+d6-d7= 300

X13+X23+X33+d8-d9= 400

32X11+50X12+36X13+40X21+40X22+60X23+56X31+70X32+34X33+d10-d11=58000

Supply constraint:

X11+X21+X31<=250

X12+X22+X32<=350

X13+X23+X33<=450

labelling

Non-negativity

QBUS2310 BY Joy

53

According to the python solution above, the optimal solution is that:

50 of pallets of product will be transferred to Penrith from Chipping Norton

150 of pallets of product will be transferred to Penrith from Casula

300 of pallets of product will be transferred to Bankstown from Casula

200 of pallets of product will be transferred to Northmead from Wetherill Park

250 of pallets of product will be transferred to Northmead from Chipping Norton

Target?

QBUS2310 BY Joy

54

Part C Reducing the cost by 50%

In this case, the goal of total cost now is only 29,000, which is a half of the original goal. By re-calculating, the process and the solution are showed below:

The new solution now is that:

200 of pallets of product will be transferred to Penrith from Wetherill Park

300 of pallets of product will be transferred to Bankstown from Chipping Norton

400 of pallets of product will be transferred to Northmead from Casula

The thing founded is that: The safety stock will not be used at all under this restriction of the delivery cost. The reason behind it is that, because of that serious restriction of cost, the company has to reduce the delivery cost by transferring less goods than before, even some customers' demand may not be satisfied.

55