



Topic: Matrix Applications 1

Time: 45 mins

Marks:

/45 marks

Calculator Assumed

Question One: [2, 4: 6 marks]

The Starbucks coffee shop has muffins for sale. They have three different varieties; choc chip, banana and apple-cinnamon.

In a large department store there is a Starbucks coffee shop upstairs and another one downstairs and they are both owned by the same person. On one weekend, the owner counted the number of muffins sold at both the upstairs and downstairs coffee shops.

The sales were split into day and evening with the following results:

	Choc.	Banana	Apple-Cinn.	
Upstairs	65	10	23	Day
U =	54	2	12	Evening

	Choc.	Banana	Apple-Cinn.	
Downstairs D =	77	7	11	Day
	21	6	12	Evening

- Calculate the $U+D$ matrix.
- The profit on each muffin sold is \$2.90. Calculate the total profit using matrix calculations.

Question Two: [3, 3, 2: 8 marks]

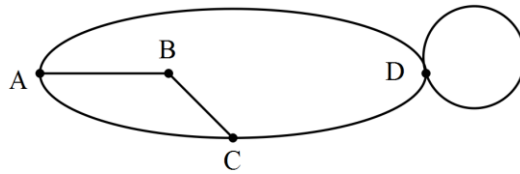
A fish and chip shop offers three packages; the COUPLES, the FAMILY and the MEGA FAMILY. The COUPLES has 2 pieces of fish, 200g hot chips and 4 potato scallops. The FAMILY has 6 pieces of fish, 800g hot chips and 9 potato scallops. The MEGA FAMILY has 10 pieces of fish, 1.5 kg hot chips and 15 potato scallops.

- a) Represent this information in a clearly labeled 3×3 matrix.
- b) On Friday the shop has orders for 20 COUPLES, 50 FAMILY and 16 MEGA FAMILY. Calculate, using matrix methods, the number of pieces of fish, the number of kilos of chips and the number of potato scallops needed to fill the orders.
- c) The cost to the shop for each piece of fish is \$12.50, \$0.90/kg chips and \$1.10 for each potato scallop. What was the total cost for Friday's orders?

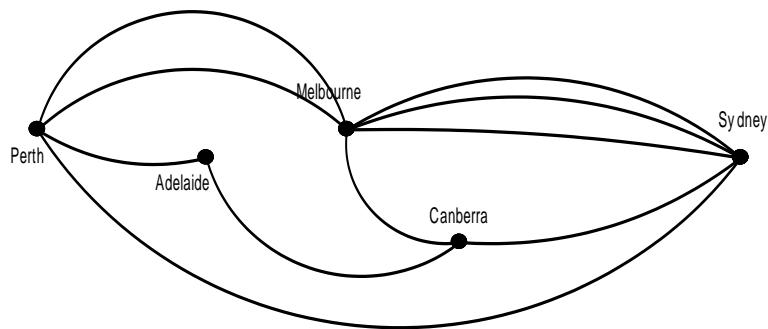
Question Three: [2, 2, 2: 6 marks]

Determine the one-stage (direct) route matrix for each of the following networks.

a)



b)



c) Determine the two-stage route matrices for each of the networks from part a) and b) above.

Question Four: [3, 2, 2, 2, 2, 3, 2: 16 marks]

Pleasantry College is a private school operating in TAS, VIC, SA and ACT. They take primary school and high school students and break down some of their costs per enrollment per day as follows:

$$\begin{array}{l} \text{Primary} \quad \text{High} \\ \text{Materials} \\ \text{Labour} \\ \text{Insurance} \end{array} \begin{bmatrix} \$9 & \$12 \\ \$13 & \$20 \\ \$4 & \$5 \end{bmatrix} = P$$

- a) Find $200P$ and explain the information contained in the matrix.
- b) The head office, which oversees all of the Pleasantry Colleges, has the following information summarized in a matrix. Explain the information contained in the matrix.

$$\begin{array}{l} \text{TAS} \quad \text{VIC} \quad \text{ACT} \quad \text{SA} \\ \text{Primary} \\ \text{High} \end{array} \begin{bmatrix} 97 & 1223 & 57 & 670 \\ 65 & 1982 & 98 & 721 \end{bmatrix}$$

- c) Use matrix methods to calculate the costs of materials, labour and insurance for each college to run per day.

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- d) Use matrix methods to calculate the total costs to each college per day.

- e) Use matrix methods to calculate the total number of primary school and high school enrollments across all four colleges.

- f) Pleasantry College charges \$7000 per year for primary school students, and \$10000 per year for high school students. Use matrix methods to calculate the total income generated per day across all Pleasantry Colleges. Note that the Australian school year is 200 days.

- g) Hence, or otherwise, calculate the profit generated by all Pleasantry Colleges per day (Income – Costs).

Question Five: [3, 2, 4: 9 marks]

A home wares store has a regular monthly delivery from each of two suppliers of towels.

Each month the store receives from the first supplier 1200 bath sheets and 600 towels. Of these, 200 of the bath sheets and 500 of the towels are white. The rest are brown.

- a) Construct a matrix \mathbf{S}_1 to contain this information. Label the rows and columns.

Similarly, each month the store receives from a different supplier 1100 bath sheets and 800 towels. Of these 700 of the bath sheets and 600 of the towels are white. The rest are brown.

- b) Construct matrix \mathbf{S}_2 containing this information. Use the same labels on the rows and columns as for \mathbf{S}_1 .

- c) Find $T = 12(S_1 + S_2)$ and explain what information is contained in matrix T.



Matrix Applications 1 SOLUTIONS

Time: 45 mins

Marks: /45 marks

Calculator Assumed

Question One: [2, 4: 6 marks]

The Starbucks coffee shop has muffins for sale. They have three different varieties; choc chip, banana and apple-cinnamon.

In a large department store there is a Starbucks coffee shop upstairs and another one downstairs and they are both owned by the same person. On one weekend, the owner counted the number of muffins sold at both the upstairs and downstairs coffee shops.

The sales were split into day and evening with the following results:

	Choc.	Banana	Apple-Cinn.	
Upstairs	65	10	23	Day
U =	54	2	12	Evening

	Choc.	Banana	Apple-Cinn.	
Downstairs D =	77	7	11	Day
	21	6	12	Evening

- a) Calculate the U+D matrix.

$$\begin{bmatrix} 142 & 17 & 34 \\ 75 & 8 & 24 \end{bmatrix} \quad \checkmark \quad \checkmark$$

- b) The profit on each muffin sold is \$2.90. Calculate the total profit using matrix calculations.

$$\begin{bmatrix} 2.90 & 2.90 \end{bmatrix} \begin{bmatrix} 142 & 17 & 34 \\ 75 & 8 & 24 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \$870 \quad \checkmark \quad \checkmark \quad \checkmark \quad \checkmark$$

Question Two: [3, 3, 2: 8 marks]

A fish and chip shop offers three packages; the COUPLES, the FAMILY and the MEGA FAMILY. The COUPLES has 2 pieces of fish, 200g hot chips and 4 potato scallops. The FAMILY has 6 pieces of fish, 800g hot chips and 9 potato scallops. The MEGA FAMILY has 10 pieces of fish, 1.5 kg hot chips and 15 potato scallops.

- a) Represent this information in a clearly labeled 3x3 matrix.

✓

	Fish	H C	P S
COUPLES	2	200	4
FAMILY	6	800	9
MEGA FAMILY	10	1500	15

✓

- b) On Friday the shop has orders for 20 COUPLES, 50 FAMILY and 16 MEGA FAMILY. Calculate, using matrix methods, the number of pieces of fish, the number of kilos of chips and the number of potato scallops needed to fill the orders.

✓

$$\begin{bmatrix} 20 & 50 & 16 \end{bmatrix} \begin{bmatrix} 2 & 200 & 4 \\ 6 & 800 & 9 \\ 10 & 1500 & 15 \end{bmatrix} = \begin{bmatrix} 500 & 68000 & 770 \end{bmatrix}$$

✓

500 pieces of fish, 68 kg of hot chips and 770 potato scallops ✓

- c) The cost to the shop for each piece of fish is \$12.50, \$0.90/kg chips and \$1.10 for each potato scallop. What was the total cost for Friday's orders?

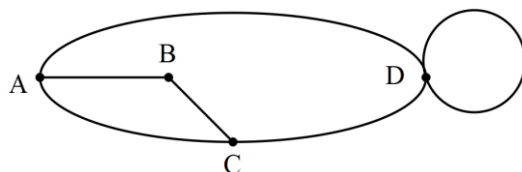
✓

$$\begin{bmatrix} 500 & 68 & 770 \end{bmatrix} \begin{bmatrix} 12.50 \\ 0.90 \\ 1.10 \end{bmatrix} = \$7\,158.20 \quad \checkmark$$

Question Three: [2, 2, 2: 6 marks]

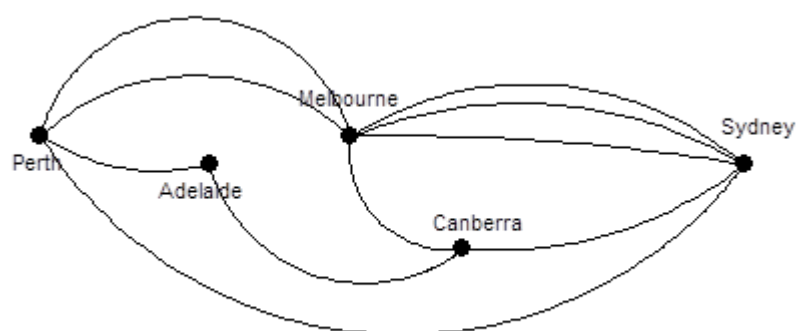
Determine the one-stage (direct) route matrix for each of the following networks.

a)



	A	B	C	D
A	0	1	1	1
B	1	0	1	0
C	1	1	0	1
D	1	0	1	2

b)



	P	A	M	C	S
P	0	1	2	0	1
A	1	0	0	1	0
M	2	0	0	1	3
C	0	1	1	0	1
S	1	0	3	1	0

c) Determine the two-stage route matrices for each of the networks from part a) and b) above.

	A	B	C	D
A	3	1	2	3
B	1	2	1	2
C	2	1	3	3
D	3	2	3	6

	P	A	M	C	S
P	6	0	3	4	6
A	0	2	3	0	2
M	3	3	14	3	3
C	4	0	3	3	3
S	6	2	3	3	11

Question Four: [3, 2, 2, 2, 2, 3, 2: 16 marks]

Pleasantry College is a private school operating in TAS, VIC, SA and ACT. They take primary school and high school students and break down some of their costs per enrollment per day as follows:

$$\begin{array}{l} \text{Primary} \quad \text{High} \\ \text{Materials} \\ \text{Labour} \\ \text{Insurance} \end{array} \begin{bmatrix} \$9 & \$12 \\ \$13 & \$20 \\ \$4 & \$5 \end{bmatrix} = P$$

- a) Find $200P$ and explain the information contained in the matrix.

$$200 \begin{bmatrix} 9 & 12 \\ 13 & 20 \\ 4 & 5 \end{bmatrix} = \begin{bmatrix} 1800 & 2400 \\ 2600 & 4000 \\ 800 & 1000 \end{bmatrix}$$

The cost per enrollment for 200 days of operation.

- b) The head office, which oversees all of the Pleasantry Colleges, has the following information summarized in a matrix. Explain the information contained in the matrix.

$$\begin{array}{l} \text{Primary} \\ \text{High} \end{array} \begin{array}{cccc} \text{TAS} & \text{VIC} & \text{ACT} & \text{SA} \\ \begin{bmatrix} 97 & 1223 & 57 & 670 \\ 65 & 1982 & 98 & 721 \end{bmatrix} \end{array}$$

The number of each type of enrollment at each college.

- c) Use matrix methods to calculate the costs of materials, labour and insurance for each college to run per day.

$$\begin{bmatrix} 9 & 12 \\ 13 & 20 \\ 4 & 5 \end{bmatrix} \begin{array}{cccc} \text{TAS} & \text{VIC} & \text{ACT} & \text{SA} \\ \begin{bmatrix} 97 & 1223 & 57 & 670 \\ 65 & 1982 & 98 & 721 \end{bmatrix} \end{array} = \begin{bmatrix} 1653 & 34791 & 1689 & 14682 \\ 2561 & 55539 & 2701 & 23130 \\ 713 & 14802 & 718 & 6285 \end{bmatrix}$$

$$\begin{array}{l} \text{Materials} \\ \text{Labour} \\ \text{Insurance} \end{array} \begin{bmatrix} 1653 & 34791 & 1689 & 14682 \\ 2561 & 55539 & 2701 & 23130 \\ 713 & 14802 & 718 & 6285 \end{bmatrix}$$

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- d) Use matrix methods to calculate the total costs to each college per day.

$$\begin{array}{cccc}
 & & \text{TAS} & \text{VIC} & \text{ACT} & \text{SA} \\
 [1 & 1 & 1] \begin{bmatrix} 1653 & 34791 & 1689 & 14682 \\ 2561 & 55539 & 2701 & 23130 \\ 713 & 14802 & 718 & 6285 \end{bmatrix} = [\$4927 & \$105132 & \$5108 & \$44097]
 \end{array}$$

- e) Use matrix methods to calculate the total number of primary school and high school enrollments across all four colleges.

$$\begin{bmatrix} 97 & 1223 & 57 & 670 \\ 65 & 1982 & 98 & 721 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 2047 \\ 2866 \end{bmatrix}$$

2047 primary school students in total

2866 high school students in total

- f) Plesantry College charges \$7000 per year for primary school students, and \$10000 per year for high school students. Use matrix methods to calculate the total income generated per day across all Plesantry Colleges. Note that the Australian school year is 200 days.

$$\frac{1}{200} [7000 \quad 10000] \begin{bmatrix} 2047 \\ 2866 \end{bmatrix} = \$214\,945/\text{day}$$

- g) Hence, or otherwise, calculate the profit generated by all Plesantry Colleges per day (Income – Costs).

$$214\,945 - (4927 + 105132 + 5108 + 44097) = \$55681$$

Question Five: [3, 2, 4: 9 marks]

A home wares store has a regular monthly delivery from each of two suppliers of towels.

Each month the store receives from the first supplier 1200 bath sheets and 600 towels. Of these, 200 of the bath sheets and 500 of the towels are white. The rest are brown.

- a) Construct a matrix S_1 to contain this information. Label the rows and columns.

✓

	Sheets	Towels
White	200	500
Brown	1000	100

$$= S_1$$

Similarly, each month the store receives from a different supplier 1100 bath sheets and 800 towels. Of these 700 of the bath sheets and 600 of the towels are white. The rest are brown.

- b) Construct matrix S_2 containing this information. Use the same labels on the rows and columns as for S_1 .

	Sheets	Towels
White	700	600
Brown	400	200

$$= S_2$$

- c) Find $T = 12(S_1 + S_2)$ and explain what information is contained in matrix T.

$$T = \begin{bmatrix} 10800 & 13200 \\ 16800 & 3600 \end{bmatrix}$$

Matrix T shows the annual delivery of each type of towel in each colour.