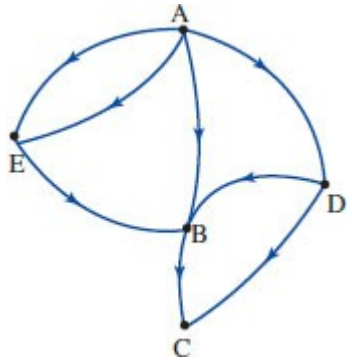
Chapter review

MULTIPLE CHOICE

1. The two-stage pathway(s) from A to C in the directed graph shown is/are:



A. A–B–C

B. A–E–B–C

C. A–D–B–C and A–B–C

D. A–B–C and A–D–C

E. A–D–C

Questions **2** to **5** refer to the following table:

Activity	Time	Immediate predecessor
A	12	—
B	11	A
C	13	—
D	24	A, C
E	11	D, B
F	21	E

2. Using the table above, the activities that come before activity E are:

A. D and B

B. A, D and B

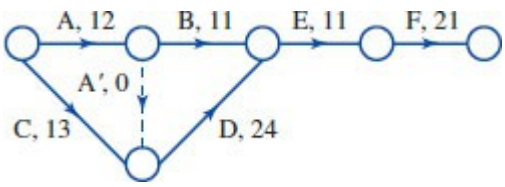
C. A, B, C and D

D. A, C and D

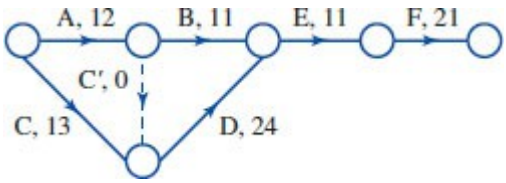
E. F

3. The correct diagram for the table above is:

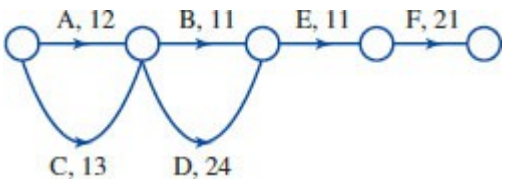
A.



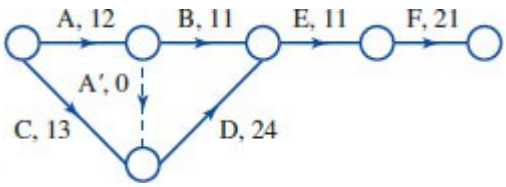
B.



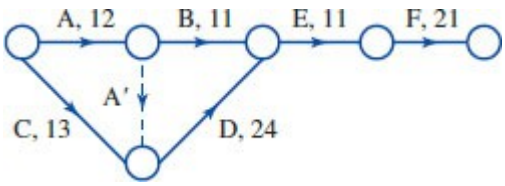
C.



D.



E.



4. The earliest start time for activity E is:

   A. 23

   B. 24

   C. 37

   D. 36

   E. none of these

5. The earliest completion time for the network is:

   A. 56

   B. 55

   C. 68

   D. 69

   E. 70

6. The times missing from the table below for activities B and C respectively are:

Activity	Activity time	Earliest start time	Earliest finish time	Float time
A	3	0	3	0
B		0	7	2
C	6	3		0
D	2	5	9	2

A. 5 and 9

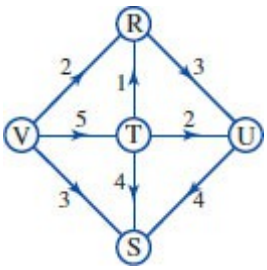
B. 5 and 8

C. 0 and 9

D. 9 and 5

E. 9 and 0

7. The source and sink, respectively, for the network flow diagram below are:



A. V and U

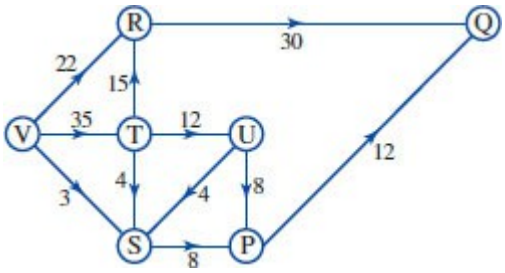
B. U and V

C. S and V

D. V and S

E. R and S

8. The outflow from node T is:



A. 35

B. 27

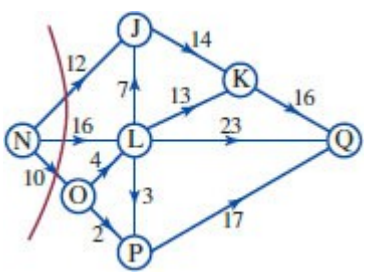
C. 31

D. 24

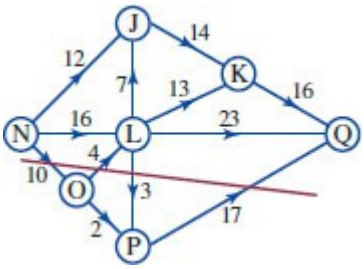
E. more than 1 possible outflow

9. The diagram that shows the minimum cut is:

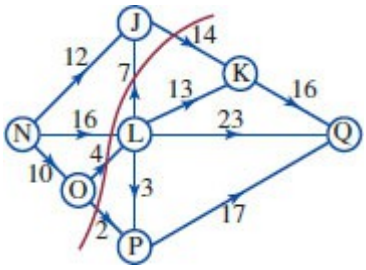
A.



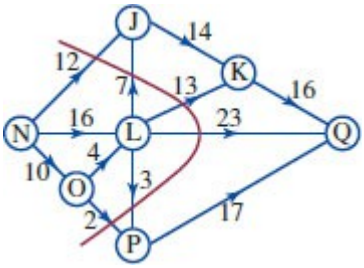
B.



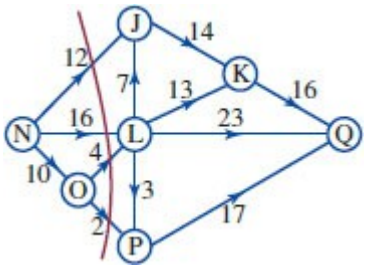
C.



D.



E.



10. Which of the following do *not* show valid cuts?

A. **a** and **c**

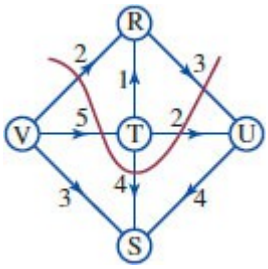
B. **d** and **e**

C. **a** and **d**

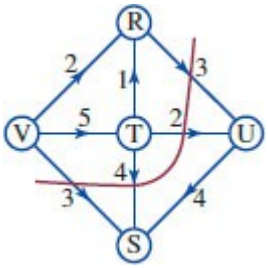
D. **c** only

E. They are all cuts.

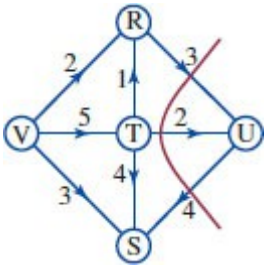
a.



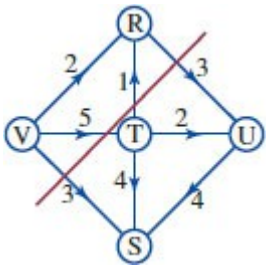
b.



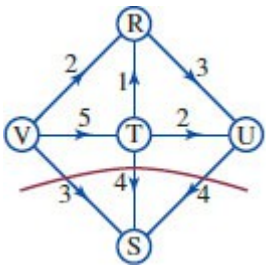
c.



d.



e.



Questions **11** and **12** refer to the following matrix.

$$\begin{bmatrix} 15 & 11 & 16 & 6 \\ 13 & 5 & 2 & 12 \\ 4 & 2 & 11 & 14 \\ 12 & 7 & 12 & 10 \end{bmatrix}$$

11. Which of the following is the row-reduced matrix for the matrix above?

A. $\begin{bmatrix} 9 & 5 & 10 & 0 \\ 11 & 3 & 2 & 10 \\ 2 & 0 & 9 & 12 \\ 5 & 0 & 5 & 5 \end{bmatrix}$

B. $\begin{bmatrix} 11 & 6 & 14 & 0 \\ 9 & 3 & 0 & 6 \\ 0 & 0 & 9 & 8 \\ 8 & 5 & 10 & 4 \end{bmatrix}$

C. $\begin{bmatrix} 9 & 5 & 10 & 0 \\ 11 & 3 & 0 & 10 \\ 2 & 0 & 9 & 12 \\ 5 & 0 & 5 & 3 \end{bmatrix}$

D. $\begin{bmatrix} 9 & 5 & 10 & 6 \\ 11 & 3 & 2 & 10 \\ 2 & 2 & 9 & 12 \\ 7 & 5 & 5 & 5 \end{bmatrix}$

E. $\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$

12. After column reduction, the matrix is:

A. $\begin{bmatrix} 7 & 5 & 10 & 0 \\ 9 & 3 & 0 & 10 \\ 0 & 0 & 9 & 12 \\ 3 & 0 & 5 & 3 \end{bmatrix}$

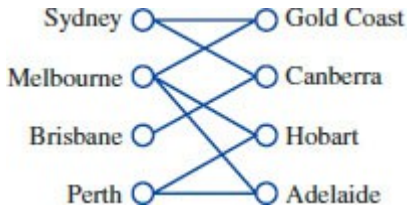
B. $\begin{bmatrix} 7 & 3 & 8 & 1 \\ 9 & 1 & 0 & 5 \\ 0 & 0 & 7 & 7 \\ 5 & 3 & 3 & 0 \end{bmatrix}$

C. $\begin{bmatrix} 7 & 5 & 8 & 0 \\ 9 & 3 & 0 & 10 \\ 0 & 0 & 7 & 12 \\ 3 & 0 & 3 & 5 \end{bmatrix}$

D. $\begin{bmatrix} 11 & 6 & 14 & 0 \\ 9 & 3 & 0 & 6 \\ 0 & 0 & 9 & 8 \\ 8 & 5 & 10 & 4 \end{bmatrix}$

E. $\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{bmatrix}$

13. For the graph of flights between cities below, which statement is not true?



A. There are more flights leaving Melbourne and Brisbane than there are leaving Sydney and Perth.

B. Brisbane has the least flights leaving it.

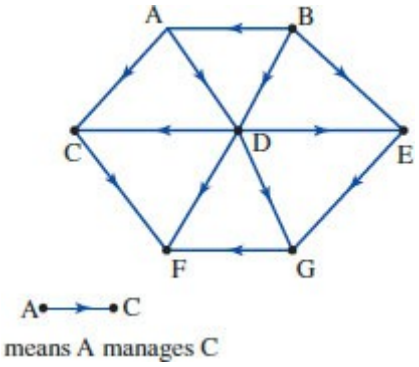
C. All destinations have the same number of flights arriving.

D. Melbourne has twice as many flights leaving it as does Brisbane.

E. Sydney has twice as many flights leaving it as does Brisbane.

SHORT ANSWER

1. The hierarchy of a business is outlined by the directed network below, where each vertex represents an employee.



a. Determine which employees are dominant over employee D.

b. Which employee has the greatest influence?

c. Which employee has the least influence?

The following information relates to questions **2** to **5**. The following precedence table has been provided for the movement of stock within a store during a refit. The junior manager has been given the task of planning the operation so that the total time taken by the project is at a minimum and that staff are used most efficiently. All time is in hours.

Task	Time	Immediate predecessor
A	3	—
B	5	—
C	4	B
D	8	A, B
E	1	D, G
F	1	E
G	2	C
H	3	D
J	4	H
K	3	F, J

2. Produce a network diagram from the information in the table.

3. Determine, by forward scanning, the earliest completion time for the refit.
4. Perform a backward scan and clearly show the critical path.
5. Copy the table, adding columns for earliest start, earliest finish and float times. Complete the table.
6. From the following flow table produce a network flow diagram.

From	To	Flow quantity
A	B	13
A	C	6
B	C	10
B	D	4
C	D	3
C	E	14
D	F	10
E	F	15

7.
   a. Show the minimum cut on your diagram from question **6**.
   b. Hence, state the maximum flow.

The table below is for use in questions **8** and **9**.

From	To	Flow quantity
A	B	13
A	C	6
A	G	16
B	C	10
B	D	4
B	G	2
C	D	3
C	E	14
D	F	10
E	F	15
G	D	3
G	H	10
H	F	13

8. Draw the network flow diagram for the table above.
9.
   a. Find the maximum flow.
   b. Show the minimum cut.

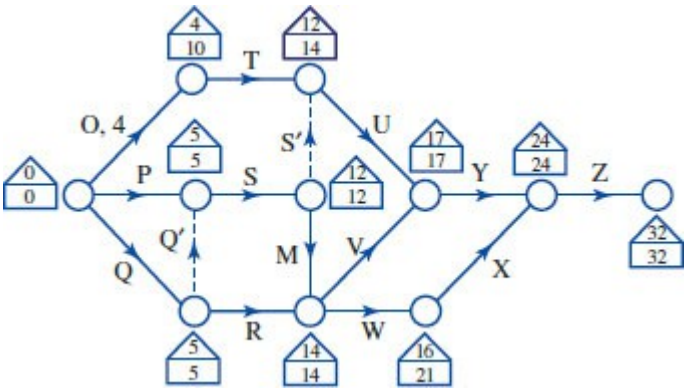
The following data refer to questions **10** to **13**. A gymnastics team of four — Annie, Beth, Consuela and Dianelle — has been selected. The team has been rated on four pieces of apparatus as follows:

	Vault	Uneven	Beam	Floor
Annie	5	7	5	9
Beth	6	10	10	7
Consuela	7	5	3	8
Dianelle	7	8	8	9

10. Convert the table for a minimisation problem.
11. Perform a row reduction on the matrix.
12. Perform a column reduction on the matrix produced for question 11.
13.
    a. Apply the Hungarian algorithm.
    b. Hence, state the optimum team make-up.

EXTENDED RESPONSE

1. The following network diagram was produced by a manager of a construction project. Unfortunately, he is not very competent and has forgotten to write the times for the activities on the diagram.



He has also lost most of the information from the original table that was used to produce the diagram. All the information that's left is in the table below. He has decided that if he is to lose his job then you, as his junior, will go too, unless you can fill in the information missing from the diagram and the table.

Activity letter	Immediate predecessor	Time	Earliest start time	Latest finish time	Float time
O	—				
P	—				1
Q	—				
R	Q				6
S	P, Q				
T	O				6
U	S, T				2
M	S				
V	R, M				
W	R, M				5
X	W				5
Y	U, V				
Z	X, Y				

a. Copy the diagram and indicate the (one) critical path. Copy the table.

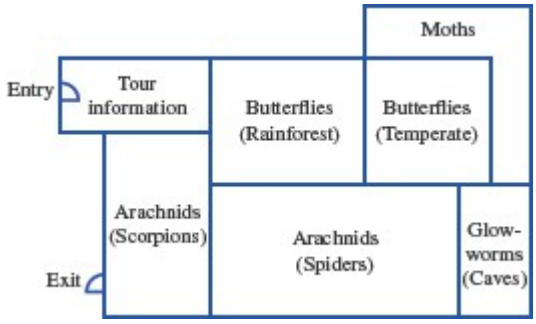
b. First complete the missing float time column in the table.

c. Complete the earliest start time column in the table.

d. Complete the latest finish time column in the table.

e. Now, complete the time column for each activity and put these times into your copy of the diagram.

2. A Lepidoptera and Arachnid building is to be set up at the zoo. The floor plan is shown below.



The building is to be designed so that the people can flow through in one direction only. Each doorway will open only one way and is designed to ensure that there is no mixing of the exhibits.

a. Draw the doors leading from one section to the next, clearly indicating in which direction they open. (The entry and exit doors have been completed for you.)

An analysis of the times spent in similar exhibits in zoos in other cities has provided the following table.

Section from	Section to	Arrival rate
Entry	Tour information	12
Tour information	Rainforest butterflies	13
Rainforest butterflies	Temperate butterflies	12
Temperate butterflies	Moths	2
Temperate butterflies	Glow-worms	4
Temperate butterflies	Arachnids	2
Moths	Glow-worms	4
Glow-worms	Spiders	6
Spiders	Scorpions	5
Scorpions	Exit	12

b. If the doors at the entry can be represented by an edge (A) with a capacity of 12, convert the information given in the chart and plan to a network flow diagram using the letters A to J.

c. Analyse the inflows, capacities and outflows and then describe what would happen to the number of people in the Rainforest Butterflies room.

d.

i. Draw the minimum cut.

ii. State at what rate people should be admitted so that they can flow smoothly through the building.



3. Imagine it is the year 2031, and the Australian Democrats have won the Federal election with 71 members in the House of Representatives and 29 Senators. The party has decided to do things differently when it comes to selecting its top four officials, namely Prime Minister, Treasurer, Foreign Minister and Speaker of the House. It will allow each of the 100 members of the caucus to 'elect' them according to the following rules:

   i. Anyone can nominate for *all* positions.

   ii. Members cast one vote for *each* position, but can pick a person for two or more positions.

   iii. The four winners will be selected so that the *total* number of votes received for the four positions is a maximum.

   There were five candidates in all — Alice Anderson, Boris Bologna, Cristina Colokis, Daniel Davis and Emily Eastwood — and the results of the poll were:

	Prime Minister	Treasurer	Foreign Minister	Speaker
A. Anderson	48	35	31	22
B. Bologna	1	10	5	4
C. Colokis	8	35	31	22
D. Davis	2	9	15	39
E. Eastwood	41	11	17	8

a. Since there are five people and only four positions, what should be done to the matrix so that an allocation algorithm can be applied?

b. Since the problem requires a maximum total, what should be done next so that the allocation algorithm can be applied?

c. Perform row reduction on your modified matrix.

d. Perform column reduction (if required) on your modified matrix.

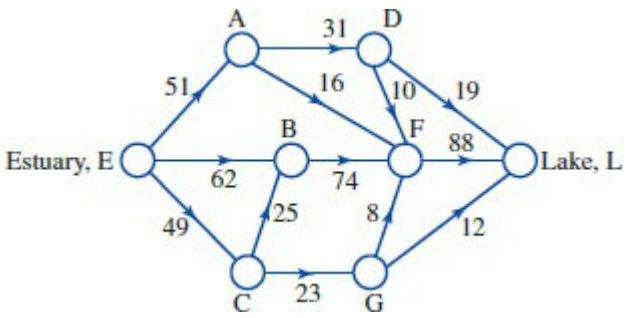
e. Perform the Hungarian algorithm (if required) on your modified matrix.

f. Determine the optimal allocation.

g. Discuss the implications of the result in terms of candidates who got the most votes for a position (for example, D. Davis for Speaker) actually getting the position.

h. If your answer to part **g** was negative, discuss why this might have happened.

4. The network diagram below represents the flow of salmon up the main tributaries of a river system during their spawning run, which leads from the estuary, E, to the lake, L. The figures represent the number of fish that pass along each section of the system every hour.



a. Which are the source and sink nodes?

b. Determine the inflow and outflow for all other nodes.

c. Does a pattern exist between the inflows and outflows? If so, give a possible reason for the pattern.

d. Determine the flow capacity of the river network.

e. Find the maximum flow for the network.

Units: **3 & 4**

AOS: **5**

Topic: **2**

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