UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	NETWORK FLOW
COURSE CODE	:	BWA 31003
PROGRAMME CODE	:	BWA
EXAMINATION DATE	:	JUNE / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 Consider a network (N, A), where N is the set of nodes and A is the set of arcs as illustrated in **Figure Q1**.

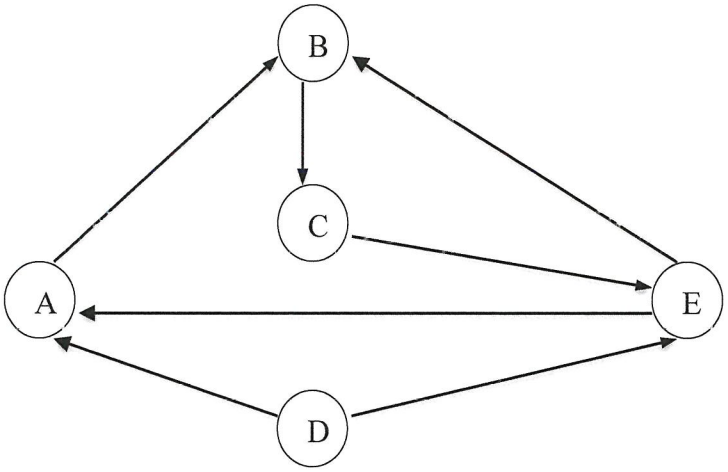

Figure Q1

For the network in **FIGURE Q1**, determine

(a) a path,

(1 mark)

(b) a directed cycle,

(1 mark)

(c) a spanning tree.

(1 mark)

Q2 A telecommunication company needs to provide cable service to five towns. The distances in km between town 1 (node 1) and four other towns (node 2-5) are given in **Figure Q2**.

	1	2	3	4	5
1	0	1	4	2	6
2	1	0	3	3	-
3	4	3	0	2	5
4	2	3	2	0	4
5	6	-	5	4	0

Figure Q2

(a) Draw the network.

(4 marks)

(b) Determine the most economical cable network.

(6 marks)

Q3 **Figure Q3** shows the road which link 6 cities i.e. A, B, ..., F. The arcs represent the road and the distances (in km) are given on each arc. The arcs with arrow represent the roads which allow one direction only while the arcs without arrow represent the roads which allow both directions.

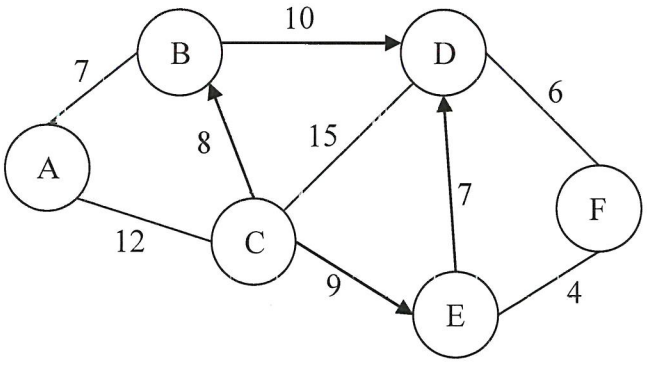

Figure Q3

(a) By using an appropriate method, find the shortest routes between every two cities.
(12 marks)

(b) Formulate the linear programming model for the shortest route problem from city A to city F.
(5 marks)

Q4 Consider the minimum-cost capacitated flow problem in **Figure Q4** where the b_i values (net flows generated) are given by the nodes, the c_{ij} values (costs per unit flow) are given by the arcs and the u_{ij} values (arc capacities) are given in the parentheses.

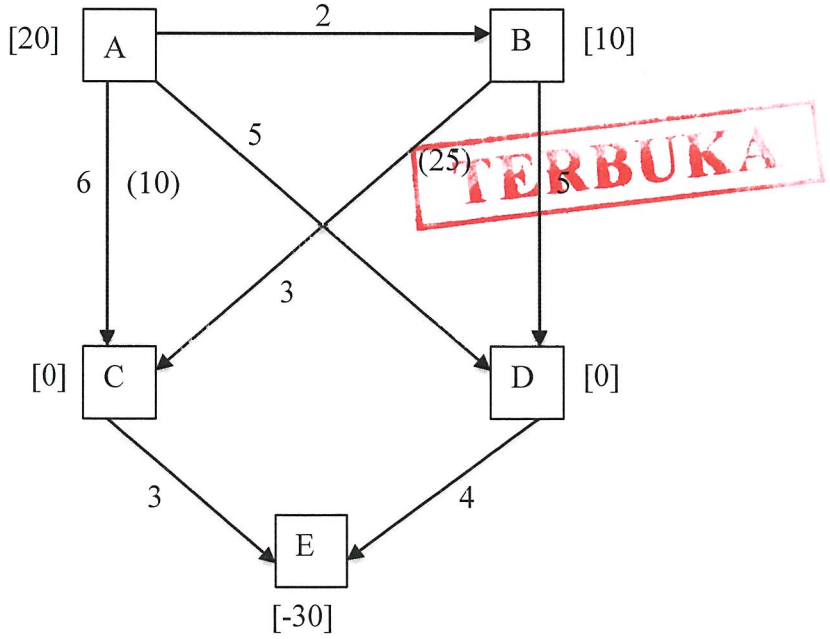

Figure Q4

(a) Starting from this basic feasible solution, where arcs $A \rightarrow D$, $B \rightarrow C$, $C \rightarrow E$ and $D \rightarrow E$ are the basic arcs, apply one iteration of the capacitated network simplex method. Identify the entering basic arc, the leaving basic arc and the next basic feasible solution, but do not proceed further.

(10 marks)

(b) Formulate the linear programming model as a minimum-cost capacitated flow problem of the network.

(5 marks)

Q5 A project comprising some activities has been identified as in **Table Q5**.

Table Q5: The estimates of duration of each activity

Task	Duration (Days)	Predecessor/s
A	7	-
B	14	A
C	10	A
D	7	C
E	5	B, D
F	7	-
G	6	F
H	7	C, G
I	7	A
J	11	I

(a) Draw the network diagram and determine the critical path of the project.

(15 marks)

(b) Determine the red-flagged activities.

(5 marks)

Q6 Faisal Industries produces two products which are product A and product B. The company has a total of 24 production hours available. Each unit of product A requires 2 hours of production time and each unit of product B requires 3 hour. The company will allow the use of overtime, but prefers to use at most 12 hours of production time. The company's marketing department has determined that it could sell at most 9 units of product A and at most 12 units of product B. Since one of the company's goals is market penetration, the company will like to sell as close to the maximum sales of each product as possible. Each unit of product A generates a revenue of RM9 and each unit of product B generates a revenue of RM10. The share-holders expect a net revenue of at least RM300. Formulate a goal programming problem for the Faisal Industries problem of determining the optimal quantity of products A and B. Note that all figures are for one working day.

(8 marks)

Q7 A human resource department of a company is allocating five representatives to three locations to do marketing. A maximum of four representatives may be allocated to any one location. Estimates of the likely sales revenue, in RM1,000. In each location as a function of the number of sales representatives are given in the **Table Q7**. The company's main objective is to maximize sale revenue.

Table Q7: Sales revenue (in RM1,000)

Location	Number of sales representative				
	0	1	2	3	4
A	55	53	76	34	53
B	65	42	35	55	66
C	49	66	44	79	33

Formulate this as a dynamic programming problem, stating clearly the recursive relationship used and defining your terms. Hence, find the optimal allocation of representatives to locations and the maximal total sales revenue.

(15 marks)

Q8 Consider the following pre-emptive goal programming model.

$$\text{Minimize } P_1\left(d_1^-\right)+P_2\left(d_2^-\right)+P_3\left(d_3^-\right)$$

subject to

$$\begin{aligned} 7x_1+3x_2+d_1^- - d_1^+ &= 40 \\ 10x_1+5x_2+d_2^- - d_2^+ &= 60 \\ 5x_1+4x_2+d_3^- - d_3^+ &= 35 \\ 100x_1+60x_2 &\le 600 \\ 2x_2 &\le 11 \\ x_1, x_2, d_1^-, d_1^+, d_2^-, d_2^+, d_3^-, d_3^+ &\ge 0 \end{aligned}$$

(a) Use the graphical goal programming procedure to solve the problem.

(10 marks)

(b) Determine the solution if the second and third priority levels are interchanged.

(2 marks)

- END OF QUESTIONS -