

This question paper consists of 4 printed pages, each of which is identified by the Code Number COMP377801

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The marks available for each question are given in brackets after the question. You need to look at these marks and allocate the time you spend on each question accordingly.

Use of a calculator is allowed.

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School of Computing

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COMP377801: DECISION MODELLING

Time allowed: 2 hours

Answer ALL THREE Questions.

Question 1

- (a) An airline is planning a new direct flight service between Leeds and Bristol. Management has to decide whether to offer a low-fare service or a premium service. Appropriate types and levels of resources (e.g. aircrafts and crews) to be used would depend on the service to be offered, and the profits are estimated based on two possible levels of passenger demand: weak or strong. The following table shows the estimated quarterly profits (in thousands of £):

	Weak Demand	Strong demand
Low-fare service	350	720
Premium service	-520	950

- (i) What is the chance event for this problem and the consequences of the management decision? **[3 marks]**
- (ii) If nothing is known about the probabilities of the chance outcomes, what is the recommended decision using the optimistic, pessimistic and minimax regret approaches? **[4 marks]**
- (iii) Preliminary market research has found that the probability of weak demand is 0.3 and the probability of strong demand is 0.7, but these probabilities might not be very accurate. Suppose you have applied the expected value approach for a decision recommendation using these probabilities (you are not required to do the actual calculations here), discuss how some sensitivity analysis might be devised for the management of the airline (no numerical calculations required). **[3 marks]**
- (iv) Assume the probabilities (0.3 for weak demand and 0.7 for strong demand) found by the preliminary market research are accurate. Furthermore, a consultant may be hired who would be able to predict perfectly the actual demand. It is not yet known whether the consultant's fees are affordable. What is the expected value of quarterly profits in anticipation of perfect demand information from the consultant? Briefly explain how a maximum fee for the consultant can be determined (no further numerical calculations required). **[5 marks]**
- (b) With reference to *Patchak* [1], discuss the roles of the human analyst and the challenges facing them in utilising "Big Data" for decision analysis. **[5 marks]**

Reference:

[1] *Patchak, W.M. "Software survey: decision analysis – Decision tools continue to evolve, providing analysts with more horsepower to transform information into decision advantage", OR/MS Today, Vol. 41, No. 5, 2014.*

[20 marks total]

Question 2

- (a) LaPomme produces 3 brands of ciders and an apple juice using apples from 6 local orchards. The apples (in tonnes) from each orchard are sorted into 3 quality grades: High, Medium and Low. The recipes for the ciders and apple juice specify the proportion of the different grades of apples to be used, but not from which orchard the apples have come from.
- (i) All the orchards have delivered their apples. LaPomme would like to draw up its production plan using up all the apples. Define the decision variables required. How many decision variables are there in total?
[4 marks]
- (ii) LaPomme has contracted an analyst to optimise its production plan using linear programming. Also, the marketing department of LaPomme is choosing one of the cider brands to be promoted by naming it after one of the orchards. The main criterion is that the orchard to be named after is the main source of apples for that brand. Discuss how the analyst might help the marketing department.
[4 marks]
- (b) A subway metro train network can be represented by a graph showing how the train stations, each represented by a single node, are connected by arcs.
- (i) Suppose passengers are only concerned about minimising journey times rather than the actual distance travelled. Explain how a route planning service could be provided for the subway metro train network, based on the above graph, using one of the models covered in this module.
[4 marks]
- (ii) After the route planning service mentioned in (i) has been implemented, some passengers complain about getting poor advice from the system. Some passengers had to wait very long for connections and some of the routes planned by the system are inefficient. Discuss two aspects of the model used that might have caused the problem.
[4 marks]
- (c) Briefly explain how the layout design of water pipes for a new housing estate can be modelled as a minimum spanning tree problem.
[4 marks]

[20 marks total]

Question 3

- (a) An investment analyst has projected possible profit returns in five years' time for a certain investment, and their associated probabilities are shown in the table below. Not making this investment incurs no penalty and the profit return will be £0.

Return (£)	30,000	20,000	10,000	0	-10,000	-20,000
Probability	0.10	0.25	0.20	0.15	0.20	0.10

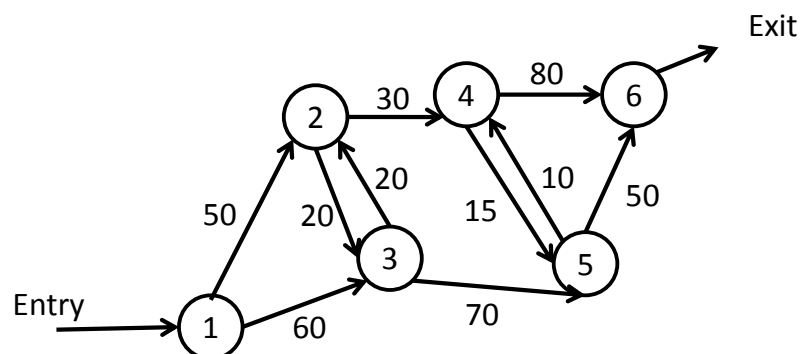
- (i) Should the analyst recommend making this investment or not based on the expected value approach? **[3 marks]**
- (ii) It is important for investment advice to take into account the client's attitude towards investment risks. Therefore, utility analysis will be performed for clients interested in making an investment. For the above investment, what is the appropriate lottery for the utility analysis experiments? **[2 marks]**
- (iii) Suppose the utility analysis experiments with a particular client have established the following indifference probabilities:

Return (£)	20,000	10,000	0	-10,000
Indifference Probability	0.95	0.70	0.50	0.25

Should the client be recommended to make the investment based on the expected utility approach? Together with the assessment in (i) above, draw a conclusion where possible.

[6 marks]

- (b) The diagram below shows a network of roads for some diverted traffic. The numbered nodes represent junctions and each directed arc represents a road connection between a pair of nodes. Traffic is unidirectional along a connection. The capacity in terms of number of vehicles per minute along each arc is as indicated in the diagram.



Formulate a linear program for determining the maximum number of vehicles per minute that can flow through the above network. *Note: You do not need to solve the linear program.*

[9 marks]

[20 marks total]

END