SPECIMEN DECISION ANALYSIS
EXAMINATION 2

Time allowed: 2 hours

Answer any THREE questions from the five questions supplied.
Question 1

The Academy of Forecasting has to decide on a location for its annual symposium. Two locations are being considered: the Heraton hotel in New York and the campus of Atlantic University. The profit that the academy will earn from the symposium depends on the cost of the location and the number of delegates attending. The cost to the Academy of holding the symposium at the Heraton will be a fixed charge of $14 000 plus an extra $100 per delegate. The Atlantic University will charge $10 000 plus an extra $120 per delegate. Delegates will pay $300 to attend the symposium, irrespective of which location is chosen.

The number of delegates attending the symposium is likely to depend on the location. For simplicity, subjective probability distributions for the number of delegates attending at each location have been approximated by the three-point distributions shown below.

<table>
<thead>
<tr>
<th>No. of delegates attending</th>
<th>Probability</th>
<th>No. of delegates attending</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.2</td>
<td>40</td>
<td>0.4</td>
</tr>
<tr>
<td>100</td>
<td>0.5</td>
<td>100</td>
<td>0.5</td>
</tr>
<tr>
<td>150</td>
<td>0.3</td>
<td>160</td>
<td>0.1</td>
</tr>
</tbody>
</table>

a) Identify the location that will maximize the expected profit earned by the Academy. (25% of marks on question)
b) What reservations do you think the Academy should have about using your analysis in part (a) to choose the location for the symposium? (25% of marks on question)
c) After a utility elicitation session, the Academy's treasurer is able to make the following statements:

‘I would be indifferent between earning a profit of $15 200 for certain and taking a gamble which had a 0.99 probability of yielding a profit of $16 000 and a 0.01 probability of yielding a loss of $4000.’

‘I would be indifferent between earning a profit of $8000 for certain and taking a gamble which had a 0.92 probability of yielding a profit of $16 000 and a 0.08 probability of yielding a loss of $4000.’

‘I would be indifferent between earning a profit of $6000 for certain and taking a gamble which had a 0.88 probability of yielding a profit of $16 000 and a 0.12 probability of yielding a loss of $4000.’

‘I would be indifferent between earning a profit of $800 for certain and taking a gamble which had a 0.6 probability of yielding a profit of $16 000 and a 0.4 probability of yielding a loss of $4000.’
i) Sketch the treasurer's utility function and interpret its shape.
ii) Explain how you arrived at your interpretation in (i).

(20% of marks on question)

d) Determine the location that the treasurer should prefer in the light of the utility function you obtained in part (c).

(15% of marks on question)

e) Briefly discuss the problems that may be associated with the use of utilities in this context.

(15% of marks on question)

Question 2

a) For each of the following subjective probability statements identify the error or bias and discuss its possible causes.

1. ‘I estimate that the probability that the United Kingdom will adopt the euro as its currency within the next ten years is 0.4.

   However, I estimate that there is a 0.6 probability that the UK will adopt the euro as its currency within the next ten years as a result of threats from international companies to move their operations outside the UK if the UK stays outside the euro zone.’

2. ‘This machine has eight key components, all of which must work if the machine is to be operational. Each key component has a 0.9 probability of working at any given time and the chance of any one component failing is independent of the state of the other components.

   I therefore estimate that there is roughly a 0.85 probability that the machine will be operational when it is needed at 12 noon tomorrow.’

3. ‘When attending next year’s sales conference in Berlin I intend to drive there from England as there have been several plane crashes in the news recently and I think that flying is too risky.’

4. ‘In June our sales of iced drinks rocketed to 3 800 000 litres as a result of a series of events that all worked in our favour. A rival’s bottling equipment temporarily failed, it was the hottest and sunniest June for 20 years, there were four major sporting events at which our advertising hoardings could be seen on television and a celebrity was seen drinking our product at a press conference. I’m heartened by this increase in sales and forecast that we will have more than a 99% chance of achieving sales of at least 3 800 000 litres again next month.’
5. ‘We know that each of our 11 players has a 10% chance of suffering an injury in any game. Therefore I estimate that the probability that at least one player will be injured in next week’s game is about 14%.’

6. ‘We have not had a major accident in this factory for 25 years. Because such a long accident-free period is statistically unlikely, I’m concerned that the next major accident is overdue and I urge all of our employees to be extra vigilant about safety matters.’

(75% of marks on question)

b) Probability wheels, event trees and fault trees have all been used to elicit subjective probabilities. To what extent are these devices likely to improve the accuracy of subjective probability estimates? Give reasons for your answer.

(25% of marks on question)

Question 3

An office manager has to choose a new personal computer. In order to help with the decision she derives the following value tree to determine the attributes that are relevant to her problem.

![Value Tree Diagram]

a) Keeney and Raiffa have suggested five criteria for assessing the validity of a value tree: i) completeness, ii) absence of redundancy, iii) decomposability, iv) operationality and v) minimum size.

Explain how these criteria apply to the office manager's value tree.

(35% of marks on question)
b) After deriving the value tree the manager decides to gather information relating to the attributes of 15 makes of computer that can be purchased, given her budget. Having gathered this information, she decides to make the decision without using a normative decision model. Discuss, in the context of her problem, the heuristics that she might adopt in choosing between the computers, according to the research literature, and the biases that are likely to be associated with the use of these heuristics.

(35% of marks on question)

c) Much of the research literature on human judgment suggests that unaided decision makers suffer from major deficiencies both when facing multi-attribute decisions and when making judgments about uncertainty. How reliable are these conclusions from the research? Give reasons for your answer.

(30% of marks on question)

Question 4

A major retailer is planning to build a new distribution warehouse in the Midlands. Five possible sites have been identified: Alverscombe, Benfield, Cadthorpe, Derrington and Eltin. The choice of site will be based on four attributes: i) Costs, ii) Distance from nearest motorway, iii) Availability of a local labor force and iv) Scope for future expansion. The costs have been discounted to present value, while scores have been assigned to the options to measure their performance on the non-monetary attributes (100 = best on that attribute, 0 = worst). The results are shown below.

<table>
<thead>
<tr>
<th>Site</th>
<th>Costs ($m)</th>
<th>Distance</th>
<th>Labor</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alverscombe</td>
<td>12.1</td>
<td>100</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Benfield</td>
<td>8.5</td>
<td>10</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>Cadthorpe</td>
<td>14.7</td>
<td>100</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Derrington</td>
<td>9.9</td>
<td>90</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Eltin</td>
<td>11.0</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

The retailer was asked to consider a hypothetical site that had Eltin's distance from the motorway, Alverscombe’s labor availability and Eltin’s scope for expansion. She was then asked, if she could improve the site so that its performance on just one of these attributes was equivalent to the best option on that attribute, which attribute would she choose? She indicated that improving the distance from the motorway was the most desirable change. Similar improvements to labor availability and scope for expansion were respectively considered to be 70% and 30% as desirable as the improvement in distance.
a) The retailer has provided information that can be used to obtain swing weights for the three non-monetary attributes. What would have been the danger of using weights based simply on the decision-maker's view of the relative importance of the attributes and how do swing weights overcome this danger?  

(15% of marks on question)

b) Aggregate scores for the non-monetary attributes have been calculated and these are shown below (the score for Alverscombe is missing)

<table>
<thead>
<tr>
<th>Site</th>
<th>Aggregate score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alverscombe</td>
<td>Missing</td>
</tr>
<tr>
<td>Benfield</td>
<td>47.0</td>
</tr>
<tr>
<td>Cadthorpe</td>
<td>82.5</td>
</tr>
<tr>
<td>Derrington</td>
<td>70.5</td>
</tr>
<tr>
<td>Eltin</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Calculate the aggregate score for Alverscombe.  

(15% of marks on question)

c) Identify the site (or sites) on the efficient frontier.  

(20% of marks on question)

d) If a site had the worst scope for expansion, the retailer would be prepared to pay an extra $3 million to improve the site so that it had the best scope for expansion, all else remaining equal. Use Edwards and Newman’s method to identify the site that the retailer should choose.  

(25% of marks on question)

e) Your recommendation in part (d) does not agree with the retailer’s ‘gut feel’. She is still unsure about what to do, but feels that another site is probably better.

i) Discuss possible reasons for this discrepancy between the model’s recommendation and the retailer’s intuitive judgment.

ii) Briefly indicate how the discrepancy might be resolved so that a requisite model is obtained.  

(25% of marks on question)
Question 5

A pharmaceutical company is to open a new laboratory near Cambridge. Four locations are being considered: Tovell Park, West Avenue, Riverside Science Park and Border Road. The directors of the company have agreed to make the decision as follows.

Stage 1 – Use of the Delphi method

The Delphi method will involve the directors each making estimates of dates when new drugs will be available and future sales volumes.

Stage 2 – Voting on the options

The outputs of the Delphi method will be used as a basis of a report written by the Chief Executive. This report will discuss the relative advantages of each location, in the light of the Delphi estimates. The report will be circulated to each director who will then vote, in a secret ballot, on his or her preferred location using the following voting system.

- The first vote will be between Tovell Park and West Avenue.
- The winner of this vote will then go forward to a second round of voting where it will compete with the Riverside Science Park.
- Finally, the winner of the second round vote will compete in a final round of voting with the Border Road location. The winner of this final vote will be the chosen location.

Discuss the potential advantages and disadvantages of using this decision process to choose the location of the new laboratory.