NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH

SORS4101: DECISION ANALYSIS

BSc. Operations Research and Statistics: Part IV

AUGUST 2024 SUPPLEMENTARY EXAMINATION

Time : 3 hours

Total Marks : 100

Candidates should attempt **ALL** questions from Section A and **ANY THREE** questions from Section B. Each question should start on a fresh page.

SECTION A: Answer ALL questions in this section (40 marks).

A1. The demand for a product of a company is affected by the government policy. The effects of a policy by the government can stimulate demand. It may take no such action or it may stimulate demand but also increase corporate tax. The company must decide in advance of the government action, which is either to increase the price of the commodity or to keep at its constant level. The effects of the six possible actions on profits are as shown below.

Government Action	Estimated Profits (m)
Price remains constant: No policy action	6.0
Price remains constant: Demand stimulated	6.5
Price remains constant: Stimulation plus tax	4.5
Increase price: No policy action	5.5
Increase price: Demand stimulated	7.0
Increase price: Stimulation plus tax	4.0

If the company is too optimistic then they may incur losses when demand is not stimulated. As a result, the company chooses to be conservative.

(a) What appropriate decision should the company implement before the government does any action? [5]

(b) If the company apply a minimax regret approach in the analysis then what would be their decision? [5]

(c) If the company is 65% pessimistic then what would be their optimal decision? [4]

(d) Explain why the three approaches give different optimal decisions and yet they are being applied on the same problem. [1]

A2. A farmer packs tomatoes she produces from her plot at a cost of $10 per case and sells them at a wholesale price of $15 per case. For quite a long time now she could sell 100, 200 or 300 cases each week. If she packs more than demanded for any week then she has to throw away the cases because tomatoes can not be sold after week of being packed. If demand is more than she had packed then she buys the tomatoes from other farmers at a cost of $18 per case (that includes buying price and cost of hiring extra labour as well as transporting the tomatoes to her plot for packaging). She does that so that she maintains her reliability and dependability to her clients, so she still sells them at $15 per case.

(a) Set up a pay off table for the farmer. [5]

(b) She estimated that there are 20% chances that 100 or 200 cases may be bought in a week and 60% chances that 300 cases could be bought. How many cases should she pack in order to maximise her weekly profits? [6]

A3. (a) Distinguish between decision making under risk and decision making under conflict environments. [2]

(b) Explain when expected utility approach is more appropriate to use than the expected monetary value approach. [2]

A4. Two players are involved in the following game.

$$\begin{pmatrix} 4 & 1 \\ 2 & 3 \end{pmatrix}$$

(a) Find the optimal strategy for each player. [7]

(b) Find the value of the game. [2]

(c) Hence, who would be the winner of the game? [1]

SECTION B: Answer ANY THREE questions in this section (60 marks).

B5. Such As Investments (Pvt) Ltd. would like to buy land but has two different investment options. The economic instabilities currently prevailing in the country is making the investors difficult to ascertain the future sales on their investment. A big investment like constructing a shopping mall followed by low sales could be very costly to the investors. However, if Such As makes a conservative investment like developing town houses and finds high sales, the investor's profits will be lower than they might have been. After a thorough market and financial research the company estimated that the following annual net profits (in thousands of dollars) may be realised.

Investment Strategy	Low Profits	Medium Profits	High Profits
Residential Flats	-10	300	600
Shopping Mall	-500	200	900
Probability	0.2	0.35	0.45

(a) Use a decision tree diagram to advise Such As (Pvt) Ltd. on the best investment. [5]

(b) The company can conduct a market survey but need a total of $200 to finance it and may result in three indicators of demand namely Weak, Moderate or Strong indicator. The relationship between these demand indicators and possible net profits can be written in the following conditional probability function.

Net Profits	$P(I_i/s_j)$		
	Weak	Moderate	Strong
Low	0.6	0.3	0.1
Medium	0.4	0.4	0.2
High	0.1	0.4	0.5

Where $i =$ Weak, Moderate, Strong and $j =$ Low, Medium, High.
Hence, what would now be Such As (Pvt) Ltd. investment strategy? [15]

B6. (a) A manufacturing company would like to launch a new product. As a result, their Finance Department estimated the following profit projections and associated chances of realising them in the following table.

Profit ($)	Chance (%)
150,000	0.10
100,000	0.25
50,000	0.20
0	0.15
-50,000	0.20
-100,000	0.10

Because of the high dollar values involved, especially the possibility of a $100,000 loss, the management has expressed some concern about the risk.

(i) What would be the appropriate lottery the management should consider? [3]

(ii) Suppose that the management is indifferent on the estimated profits with the following probabilities;

<table>
<tr><th colspan="2">Indifference</th></tr>
<tr><th>Profit ($)</th><th>Probability ($p$)</th></tr>
<tr><td>100,000</td><td>0.95</td></tr>
<tr><td>50,000</td><td>0.70</td></tr>
<tr><td>0</td><td>0.50</td></tr>
<tr><td>-50,000</td><td>0.25</td></tr>
</table>

then should the company launch the new product? [9]

(b) Umlilo Electricals has seen its business expanding to the points where it needs to increase its services beyond their existing capacity. It has narrowed their options for increasing their maximum capacity to either expand their capacity at a cost of $8m$ or modernise at a cost of $5m$. Both approaches would require the same amount of time for implementation. Management believes that over the required payback period, demand will either be high or moderate. Since high demand is considered to be somewhat less likely to happen than moderate demand then the chances of high demand have been set to thirty-five percent. If demand is high then expansion would gross an estimated revenue of $12m$ but modernisation would gross on $6m$ of revenue because of a low maximum capability. On the other hand, if demand is moderate then the comparable revenues would be $7 for expansion and $5m$ for modernisation.

What would be the different possible net profits for Umlilo Electricals? [8]

B7. (a) In an election campaign, the strategies adopted by the ruling and opposition parties along with ruling party's percentage share in votes polled are as given below.

<table>
<tr><th>Ruling
Party</th><th colspan="3">Opposition</th></tr>
<tr><th></th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>1</td><td>55</td><td>40</td><td>35</td></tr>
<tr><td>2</td><td>70</td><td>70</td><td>55</td></tr>
<tr><td>3</td><td>75</td><td>55</td><td>65</td></tr>
</table>

Where "Campaigning one day in each city", "Campaigning two days in large towns" and "Spend two days in rural areas" are strategies 1, 2 and 3 respectively which can be adopted by both parties. Assuming that this is a zero sum game situation then what would be the optimum strategy for each party? Hence or otherwise find the party with the greater percentage share in the votes polled. [12]

(b) Use the Graphical method to find the probabilities of the strategies available to the second player.

$$\begin{bmatrix} -6 & 7 \\ 4 & -5 \\ -1 & -2 \\ -2 & 5 \end{bmatrix}$$

[8]

B8. A certain petroleum corporation is considering whether to go for an offshore oil drilling contract to be awarded. If they bid for the contract, then the value of the bid would be $600m$ and they have a 65% chance of winning the contract. They can use all of the $600m$ (bid value) to set up the offshore drilling operation. They may set up a new drilling operation or move already existing operation to the offshore contract site, which has proved successful. The probability of success and expected returns are as follows.

Outcome	New Operation Probability	New Operation Revenue (m)	Existing Operation Probability	Existing Operation Revenue (m)
Success	0.75	800	0.85	700
Failure	0.25	200	0.15	350

The corporation has estimated an oil production cost of about $10m$ in order to supply the contractual oil quantities.

If the corporation loses the contract, then they are left with 95% of the bid value on which they can use to modernize their existing operation (i.e 5% of the bid value would have been used in the bid casting process). However, if they do not bid for the contract then they have to use the $600m$ to modernize their existing operation. Modernizing would result in a return of either 5% or 8% on the sum invested with 45% and 55% chances respectively.

Advise the corporation on the best investment strategy to follow. [20]

END OF QUESTION PAPER