Exercise 6

1. As winter approaches, you are concerned that your dewatering system will not be able to keep the site dry and will delay progress. You know that any significant amount of rain will flood the site. Additional pumps will cut into a slim profit margin, if not generate losses. Also, delays combined with liquated damages will reduce profit. Which of these two options (do nothing or install additional pumps) is the desired option? Considering that, the probability that the rain will be less than 6 inch in 12-hour period is 0.5 (S1), the probability that the rain will reach 6 inch one time in 12-hour period is 0.3 (S2), and the probability that the rain will reach 6 inch many times in 12-hour period is 0.2 (S3). The pound values representing costs are shown in the following table.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install pumps</td>
<td>15,000</td>
<td>15,000</td>
<td>65,000</td>
</tr>
<tr>
<td>Do nothing</td>
<td>0</td>
<td>20,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

a. Identify the actions, state of nature, and payoff table and draw the decision tree.
b. Determine the better decision.

2. A university must decide between two plans for starting a graduate program in a new academic year. The goal is to maximize the increase in student population, but it is unclear whether the interest in this new area will be high, medium, or low. Projected increases in student populations and their probabilities are shown below for each plan.

<table>
<thead>
<tr>
<th>Interest</th>
<th>Probability</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plan 1</td>
</tr>
<tr>
<td>High</td>
<td>0.6</td>
<td>220</td>
</tr>
<tr>
<td>Medium</td>
<td>0.3</td>
<td>170</td>
</tr>
<tr>
<td>Low</td>
<td>0.1</td>
<td>110</td>
</tr>
</tbody>
</table>

a. Develop a decision analysis formulation for this problem by identifying the actions, state of nature, and payoff table and draw the decision tree.
b. What is the optimal action?

3. You, as a primary contractor, are suing a subcontractor over failure to complete a portion of a construction project. The subcontractor’s bonding company has offered to settle out of court for LE410,000. You are considering making a counteroffer of LE500,000. The bonding
company may accept the offer, refuse the offer and go to trial, or make a counteroffer. Your lawyer has dealt with the bonding company on similar suits. He/she says there is a 20% chance the company will counter your counteroffer with LE450,000 and 40% chance it will go to the court. If the bonding company counters your counteroffer, you can accept or decline and go to court. If the case goes to court, there is a 10% chance you will be awarded LE1,000,000 a 35% chance of a LE500,000 award, and a 55% chance of the suit’s being dismissed as trivial. What course of action should you pursue?

4. Two pumping systems A and B are suggested for supplying water. The construction cost for systems A and B is LE250,000 and LE750,000, respectively. If partial failure occurs, it is expected that damage cost for systems A and B is LE800,000 and LE150,000, respectively. If complete failure occurs, it is expected that damage cost for systems A and B is LE1,500,000 and LE600,000, respectively. The probabilities of partial and complete failures are 5% and 1%, respectively.

   a. Identify the actions, state of nature, and payoff table and draw the decision tree.
   b. Determine the better system to minimize losses.

5. Consider a project that needs 20-Mgal/day of water. Two alternatives are under study. Alternative A is to use a primary pump of 20-Mgal/day and a backup pump with the same capacity. Alternative B is to use two primary pumps of 10-Mgal/day each and a backup pump of 10-Mgal/day. The probabilities of failure for both systems are shown in the table below.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Q = 0</th>
<th>Q = 10</th>
<th>Q = 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.0025</td>
<td>0.0</td>
<td>0.9975</td>
</tr>
<tr>
<td>B</td>
<td>0.001</td>
<td>0.006</td>
<td>0.993</td>
</tr>
</tbody>
</table>

The capital cost for construction of a pumping station, in millions of dollars, is a function of flow q in million gallons/day (Mgal/day).

\[ C = 0.035q^{1.25} \]

Failure to deliver 20 Mgal/day of water is assumed to cause inconvenience and economic loss. The annual losses are estimated to be

<table>
<thead>
<tr>
<th>q (Mgal/day)</th>
<th>Annual loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$250M</td>
</tr>
<tr>
<td>10</td>
<td>$25M</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

Draw a decision tree and determine the better pump system.
6. Wildcat Oil is considering spending $100,000 to drill at a particular spot. The result of such a drilling is either a “DryWell” (of no value), a “Wet Well” (providing $150,000 in revenues) or a “Gusher” (providing $250,000 in revenues). The probabilities for these three possibilities are 0.5, 0.3 and 0.2 respectively.

(a) Draw a decision tree for the problem of deciding whether to drill or not.
(b) Solve the decision tree assuming the goal is to maximize the expected net revenue. Should the company drill?

The following problem should be done independently.
(c) Close-enough Consultants offer to use their specialized seismic hammer. This hammer returns either encouraging or discouraging results. In the past, when applied to a Gusher, the hammer always returned encouraging results. When applied to a Wet Well, it was encouraging 75% of the time and discouraging 25% of the time. When applied to a Dry Well, it was encouraging one-third of the time and discouraging two-thirds of the time. What strategy should be followed to maximize the expected net return?