1. *Location choice* As an owner of a bubble tea business you are choosing between two locations for opening a new store. Your operating profit margin (before fixed costs, such as equipment, staff training etc.) is $.80 per cup of tea sold. Which location, 1 or 2, maximizes expected profits? Assume a 1-year horizon for the full depreciation of any fixed costs (e.g. equipment).

Location 1: Demand is uniformly distributed between 3500 and 5000 cups per month

Location 2: Demand is uniformly distributed between 2000 and 5000 cups per month

Location 1: You need to buy new equipment, which you estimate to cost $5000 with probability 40% and $7000 with probability 60%.

Location 2: There is a possibility (50%) that you can purchase equipment at a reduced price of $1000 from the coffee shop currently renting the space. Otherwise, you have to buy new equipment at the same cost as at location 1.

*2) Profit Analysis:* A consumer electronics firm produces a line of battery rechargers for cell phones. The following distributions apply:

|  |  |
| --- | --- |
| Unit Price | Discrete uniform with possible prices of $23, $24, $25, and $26 |
| Unit Cost | Continuous uniform with a minimum of $12.00 and a maximum of $15.00 |
| Quantity Sold | 10,000 – 250\*Unit price, plus a random term given by a normal distribution with a mean of 0 and a standard deviation of 10 |
| Fixed Costs | Normal with a mean of $30,000 and a standard deviation of $5,000 |

1. What is the expected profit?
2. What is the probability of a loss?
3. What is the maximum loss?

*3) Cashflow Analysis:* Vinton Auto Insurance is deciding how much money to keep in its checking accounts to cover insurance claims. In the past, the company held some of the premiums it received in interest-bearing checking accounts and put the rest into investments that are not quite as liquid, but tend to generate a higher investment return. The company wants to study cash flows to determine how much money it should keep in its checking accounts to pay claims. After reviewing historical data, the company has determined that the number of repair claims filed each week is a random variable that follows the probability distribution shown in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number of Claims** | 0 | 1 | 5 | 10 |
| Probability | 0.1 | 0.5 | 0.3 | 0.1 |

The company has also determined that the **average** repair bill per claim is normally distributed with a mean of $1,200 and standard deviation of $300. To be clear, the repair bills of each individual claim are **not** normally distributed with a mean of $1,200 and a standard deviation of $300. Rather, the **average** repair bill of a batch of claims for a given week is normally distributed with a mean of $1,200 and a standard deviation of $300. In addition to repair claims, the company also receives claims for cars that have been “totaled” and cannot be repaired. There is a 15% chance of receiving one claim of this type in any week, and there is no chance of receiving more than one in any week. The repair bills for “totaled” cars is given by the following: $7500 \* X, where X is a log-normal random variable with a mean parameter of .15 and a standard deviation parameter of 0.5.

1. Develop a simulation model and report the mean total cost of all claims incurred by the company in any week.
2. Suppose that the company decides to keep $15,000 cash on hand to pay claims. What is the probability that this amount will *not* be adequate to cover claims in any given week?
3. What level of cash would the company have to have to be 97% certain they could pay all the claims in any given week?

*4) Production Planning with Returns.* A computer manufacturer sells its laptop model through a web-based distributor, who buys at a unit cost of $200 and sells at a unit price of $500. The product life cycle is so short that the distributor is given only one opportunity to order stock before the technology becomes obsolete and a new model becomes available. At the beginning of the cycle, the distributor orders a stock level in the face of uncertain retail demand. Based on similar experiences in the past, the distributor believes that a reasonable demand model is a uniform distribution with a minimum of 1,000 and a maximum of 8,000 laptops. The items originally stocked are ultimately sold, returned, or scrapped. Customers place orders on the Web, and the distributor tries to satisfy their orders from stock. If there is a stockout, demands are lost.

The computer manufacturer offers the distributor a returns policy of the following form: It will pay $100 for each returned unit at the end of the product life cycle, but only up to a maximum of 20 percent of the original number of units ordered. Excess stock that cannot be returned to the manufacturer is picked up as scrap material by an electronics recycling center, with no cost or revenue involved. The decision facing the distributor is to choose an appropriate stock level.

1. Suppose there is no ceiling on the return of excess laptops. How many laptops should the distributor stock in order to maximize its expected profit?
2. With the returns ceiling in place, how many laptops should the distributor stock?
3. In part (b), what would be the maximum expected profit for the distributor?
4. What would be the corresponding expected profit for the *manufacturer* if the manufacturing cost is $125 per laptop, and the distributor uses the policy in part (b)?

*5) Coffee Shop (HARD).*

Suppose you want to open a coffee shop. Each minute you have 0, 1, 2, or 3 customers with equal probabilities. It takes one espesso machine one minute to make one coffee. You charge $4 for one espresso drink. If the queue (line) is longer than 5 people, customers leave the shop. Operating costs of one espresso machine are fixed and equal $50000 per year, including labor costs of a barista. Your planning horizon is 1 year, which includes 300 days p. year and 8 hours p. day

1. Should you purchase one or two espresso machines?
2. Suppose you have overestimated demand. The true demand is 0, 1 or 2 customers with equal probabilities. Should you purchase one or two espresso machines?