SUID:

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Exam 3

Spring 2013

DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO.

Instructions

1. Write your SUID in the upper right corner of this exam. Do NOT write your name.

2. SHOW ALL YOUR WORK. Answers without supporting work will receive little or no credit.

3. There are 120 points on the exam and you'll have 180 minutes to complete it. Be sure to budget your time accordingly.

4. Some questions provide a blank table you can use to organize your calculations. Be sure to label the columns clearly. Where applicable, show the equation for the column in the bottom row of the table. The tables may have more rows or columns than you need.

5. Do all your work on the exam. If you need extra space, write on the backs of the pages. However, if you do write an answer on the back of a page, *be sure you've noted that near the question*.

6. Some helpful PV formulas:

$$PV = \frac{B_t}{(1+r)^t} \qquad\qquad PV = \frac{B}{r}$$

Question 1 (15 points)

A city is considering two alternatives for upgrading its aging water supply infrastructure. The plans differ in their annual costs and how fast they would complete the project. The details are shown in the table below:

Plan	Annual construction cost	Construction years
A	$5 million	1-10
B	$11 million	1-5

Both plans would reduce the city's current water costs by $4 million per year forever starting the year after construction is complete. The agency uses an interest of 5% in present value calculations.

Please calculate the net present value of each plan and indicate which one is best.

Question 2 (15 points)

A city is evaluating options for dealing with a brownfield near its downtown area. The brownfield is causing $30 million of damage (high crime, low property values, lower taxes) in its current condition. Those costs would cease if the site were remediated or shown to be clean.

The brownfield's degree of contamination is uncertain but it is known that there is a 40% chance it is highly contaminated (H), a 40% chance it is moderately contaminated (M), and a 20% chance it is not contaminated at all (N). The city has dealt with similar problems in the past and knows that it could hire an engineering firm to do any combination of the following:

- Test the site to determine the degree of contamination: cost = $2 million
- Remediate an H site: cost = $40 million
- Remediate an M site: cost = $20 million
- Remediate an N site: cost = $0

Please determine the city's best course of action and compute its expected value. You may assume that: (1) the test is always correct, (2) all costs and benefits occur in a single period (no PV calculations), and (3) that the city is risk-neutral.

Question 3 (15 points)

A major foundation would like to improve the education provided by high schools in large urban areas. It has a large budget and is considering the following options:

- Building upgrades (plan "B")
  - Pay $100M in year 0 to upgrade buildings and facilities. No other costs.
- Small schools (plan "S")
  - Pay $80M in year 0 to split large high schools into smaller ones
  - Also pay an extra $5M per year in years 1-5 to operate the new schools.
- Small classes (plan "C")
  - Pay $20M per year in years 1-5 to hire more teachers and reduce class sizes.

Please calculate the present value cost of each plan. You may assume the foundation uses an interest rate of 5% in present value calculations.

Question 3, continued

The foundation knows that plan B will succeed for certain and will produce educational benefits worth $8M every year forever starting in year 6. Plans S and C are less certain and would be evaluated in year 5. There is a 60% chance that plan S will succeed and an 80% chance C will succeed. If S succeeds, the district could continue using it for $5M per year forever starting in year 6 and it would produce gross benefits worth $21 million per year, also starting in year 6. If it fails, the district could abandon it after year 5 with no additional costs. The situation is similar with plan C except that it would cost $20M per year and would produce gross benefits of $30M per year.

Please calculate the expected net present value of each plan using a 5% interest rate, indicate which option is best, and briefly explain why it turns out that way. You may assume the foundation is risk neutral and that it is only concerned about the overall NPV of each plan (that is, considering all costs and benefits no matter who pays for or receives them).

Question 4 (15 points)

There are two options for this question: 4A and 4B. You may do EITHER one and DO NOT need to do both. However, if you do both, I'll count the one with the higher score.

Option 4A

The head of a household is concerned about consumption in two periods: 0 and 1. In period 0, she will be working and raising a young family, and her income will be $100,000; in period 1, her income will be $120,000 but her family will be older and her kids will be heading off to college. As a result, she wants to have 1.5 times as much consumption in period 1 than period 0 in order to pay for college expenses. She can borrow or save at an interest rate of 20 percent.

Please calculate her intertemporal equilibrium, determine how much she consumes in each period, calculate how much she borrows or saves in period 0, and illustrate your results with an appropriate graph.

Question 4, continued

Option 4B

A manager is considering two actions, A and B. Action A would produce $100,000 of benefits for certain. Action B is risky: there is a 70% chance it will produce $150,000 of benefits and a 30% chance it will produce $50,000. The manager is risk averse and has a utility function of the form $U(X) = X^{0.5}$ (that is, the square root of X) where X is the payoff in dollars.

What action will the manager choose? Why? What is the expected value of Action B? What is its certainty equivalent?

Question 5 (15 points)

A non-profit organization provides financial advice to low income clients. It has total costs given by TC = 450 + Q^2 (note the square) where Q is the number of people it serves per week. The demand for its services is given by the equation P = 100 – Q, and there are no other organizations providing a similar service. The organization wishes to serve as many people as possible without running a deficit.

What price should the organization charge and how many people will it be able to serve? How much profit will it earn? As a hint, the value of Q is between 41 and 51, inclusive.

Variable								
Equation								

Question 6 (15 points)

Over the last few years the cost of sequencing a person's genome (DNA) has been falling at a breathtaking rate: the cost in 2010 was about 1/1000 the cost 2007 – that is, the cost fell by about 99.9% in three years. As a result, there is an explosion of research on new genetically-based medical tests and technologies.

Suppose a biotech company is considering developing a new test that could identify a genetic predisposition to a serious disease. The process could be patented and the company would become a monopolist in the use of the test. It believes demand for the test would be given by the equation P=234 – 4*Q and it would be able to produce the test for a total cost given by TC=10*Q. Once the test has been developed, what price would the firm charge and what quantity would it produce in each year during the time it is a monopolist? What profits will it earn each year? As a hint, the quantity will be between 25 and 35.

Variable								
Equation								

Question 7 (15 points)

Now suppose the development process in Question 6 costs $12,000 (paid in year 0) and would succeed in producing the test. However, after the test is developed it would have to be approved by the Food and Drug Administration (FDA). Because the technology is very new, the firm believes there is only a 40% chance it would be approved. You may assume the FDA evaluation can be done in year 0 so if the firm goes ahead and the FDA approves the test, the profits found in Question 6 would begin to arrive in year 1. The firm would be a monopolist for 20 years (years 1-20) after which other firms would enter, the price would fall to $10 and the firm's profits would drop to 0.

Please calculate the expected net present value of the project assuming that the firm uses an interest rate of 10% in present value calculations. Should the firm undertake it?

Question 8 (15 points)

Now let's consider the consumer surplus that could be created by the test in Questions 6 and 7. Suppose the firm goes ahead with the project and the FDA approves the test. What consumer surplus will the test create during each year of the monopoly period? What CS will it produce each year after the monopoly period? What will be the overall expected present value of the CS? You may assume the government uses a 10% interest rate in its present value calculations.

Question 8, continued.

Finally, now suppose the government were to establish a $5,000 prize for the first firm to produce an FDA-approved test for this disease. Would that change the firm's decision? You may assume the firm has no competitors and the only uncertainty is whether the test would be approved by the FDA. Would it be efficient for the government to fund the prize?