SUID:

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Exam 3
Fall 2016

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 potentially helpful formulas and equations:

$$\frac{F_t}{(1+r)^t} \qquad \frac{F}{r}$$

$$U = X^a Y^{1-a} \qquad X = \frac{aM}{P_x} \qquad Y = \frac{(1-a)M}{P_y}$$

Question 1 (15 points)

An independent consultant is concerned about her consumption in two periods, 0 and 1. Her income in period 0 is $80,000 and in period 1 it will be $100,000. However, she is considering whether to take one of two training programs, A or B, that would raise her future income. The tuition and raise associated with each is shown below. Finally, she would like to have 1.25 units of consumption in period 1 for each unit of consumption in period 0, and she can borrow or lend at an interest rate of 25%.

Program	Tuition in 0	Raise in 1
A	$12,000	$40,000
B	$30,000	$50,000

Assuming she can take at most one program, please determine: ☐ which one, if any, she should take; ☐ how much she consumes in each period; and ☐ how much she borrows or saves in period 0. Finally, ☐ draw an appropriate diagram showing her intertemporal budget given what she decides about the training, an indifference curve, her equilibrium, and the amount she borrows or saves.

Question 2 (15 points)

A government is considering what to do with an old section of elevated highway. At the moment, the highway requires $5 million of maintenance every year. It's also unsightly and creates negative externalities of $3 million per year. The government is considering two options, R and S. Option R would keep the existing elevated structure but renovate it extensively. It would cost $25 million per year for four years (years 1-4). Starting in year 5 maintenance would drop permanently to zero. Option R would have no effect on the externality (it's still an elevated highway). Option S would replace the highway with a surface street. It would cost $30 million per year for 6 years (years 1-6). In year 7 the old highway would be removed (no additional cost), maintenance would drop permanently to zero, and the externality would be eliminated. Under both plans the existing highway would continue to be used (and would continue to need maintenance and create externalities) while construction is underway.

Please calculate the net present value of each plan and indicate which one is best. The city uses an interest of 3% (note: three percent) in present value calculations.

Question 3 (15 points)

A large organization is concerned about cybersecurity. It currently stores its data on several relatively old servers. There is a 40% chance the system will be breached and critical data about its customers and operations will be disclosed to the public. The organization would lose $20 million in legal costs and other liabilities if a breach occurs. It is considering two possible upgrades, C and D. Option C would centralize the data on a new high-security server. The probability of a breach would drop but the consequences of one would be much worse since more data could be stolen. Option D would keep the data distributed across multiple servers but would upgrade them and increase their security somewhat. The details of each option, including the upgrade costs of C and D, are summarized below:

Option	Upgrade cost	Probability of a breach	Loss from a breach
BAU	NA	40%	$20 M
C: Centralize	$4 M	5%	$40 M
D: Distribute	$2 M	10%	$20 M

Please determine what the organization should do, if anything. If it chooses C or D, what is the net gain? You may assume it wants to choose the option with the highest expected value. Also, please note that this problem only involves one time period and no present value calculations are needed. *Aside: these kinds of tradeoffs are also relevant for thinking about the security of the US electronic voting system.*

Question 4 (15 points)

A city is considering two plans to redevelop an abandoned section of its waterfront. Plan C would have a commercial focus. It would cost $10 million per year for 5 years (years 1-5) and would produce benefits indefinitely starting in year 6. Plan R would have a residential focus. It would cost $2 million per year for 10 years (years 1-10) and would begin producing benefits in year 11. The benefits of each plan would depend on the public's preference. There's a 25% chance the public would prefer C. If so, the benefits of C would be $4 million per year and the benefits of R would be $2 million per year. However, there's a 75% chance the public prefers R. If so, the benefits would be reversed: C would produce $2 million per year and R would produce $4 million per year. The city could adopt either plan in year 0 without knowing the public's preferred option, or it could hire a consultant to carry out a public engagement program to determine the public's preference. The program could be carried out in year 0 before the city needs to choose between the plans.

Please determine the maximum the city would be willing to pay for the public engagement program. The city uses an interest rate of 5% in present value calculations and you may assume it wants to pick the approach that produces the highest expected value.

Question 5 (15 points)

A non-profit organization provides accounting and legal advice to low and middle income individuals interested in starting their own businesses. It has total costs given by the following equation: TC = 4000 + 5*Q^2, where Q is the number of clients it serves and Q^2 indicates Q squared. The demand for its services is given by the equation P = 580 – 4*Q, and there are no other organizations nearby 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 50 and 60, inclusive.

Variable								
Equation								

Question 6 (15 points)

Recent advances in gene sequencing and the understanding of many diseases could soon be combined to allow doctors to do a far better job of tuning therapies to the needs of individual patients, a concept known as "personalized medicine". A key obstacle, however, is that new low-cost tests will be needed for detecting genetic markers and other chemicals in a patient's blood.

This problem examines a stylized version of the situation. Suppose a profit-maximizing firm is considering a research project to develop a test that would help doctors choose a personalized therapy for patients with a particular type of cancer. If it succeeds, the annual demand for the test would be given by P = 1050 – 20*Q and production costs would be given by TC = 10*Q. Assuming the firm is able to develop the test, what price would it 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 20 and 30.

Variable								
Equation								

Question 7 (15 points)

Now suppose that the research project in Question 6 would cost $25,000 and there is a 30% chance it would succeed. However, that's not the end of the story: the firm would then need to conduct a clinical trial before the Food and Drug Administration (FDA) would allow the test to be used. The trial would cost an additional $25,000 and it would have a 40% chance of resulting in FDA approval. The firm would NOT have to conduct the trial if the original project fails. To keep things simple, you may assume that the research project and the clinical trial can both be carried out in year 0, and that if they both succeed the firm would begin earning profits starting in year 1. The firm would be a monopolist for 20 years (years 1-20) after which other firms would enter the market, the price would fall to $10, and the firm's profits would drop to 0.

Please calculate the expected net present value of the research project assuming that the firm uses an interest rate of 5% 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, succeeds in developing the test, and the FDA ends up approving it. What CS will the test create during each year of the monopoly period? What CS will it produce each year after the monopoly period? Using a 5% interest rate, what is the overall expected present value of the CS?

Question 8, continued.

Finally, suppose the government offers the firm a grant of $5,000 to help cover the initial research costs. The firm would receive the $5,000 if it undertakes the project whether or not it actually succeeds in developing the test. In addition, the government offers the firm a prize of $100,000 in year 0 if it can develop the test *and* the FDA ends up approving it. If the development project fails or the FDA does not approve the test, the firm does not receive the prize.

Would this arrangement induce the firm to undertake the project? Assuming for simplicity that the government only cares about consumer surplus and its payments to the firm (that is, assuming it doesn't care about the firm's profits), what is the government's expected value from the policy above?

Have a great break!