

Name: \_\_\_\_\_

| Question | Scores |
|----------|--------|
| 1        |        |
| 2        |        |
| 3        |        |
| 4        |        |
| 5        |        |
| 6        |        |
| 7        |        |

**DUE DATE:** In class on Thursday, December 6, 2018

**INSTRUCTIONS:**

1. Answer as many of the following questions as you can and submit your answers in class on the due date. Only the *five highest scores* will be counted for your grade. All questions and sub-questions (lettered questions) are weighted equally.
2. The final draft of your answers should be composed on a word processor or else written very neatly.
3. Your answers should be presented in numerical order and provide the Question number. Make sure that your answers are stapled together.
4. Late submissions and submitting by email will *not* be accepted.
5. As noted in the Syllabus, copying the answers of a classmate or from an online source (or simply sharing answers with classmates) is grounds for receiving zero credit for the problem set and an automatic final grade of “F” in the class. If you work with a classmate, make sure that your answers are different and not exact copies.
6. Credit will be reduced for the following:
  - (a) Incorrect answers
  - (b) Illegible or disorganized answers
  - (c) Failure to show the derivation and calculation of your final answers
  - (d) Failure to compile your answers together into a single file or presenting them in order
7. A Discussion Board (“Questions about Problem Sets”) has been provided on Blackboard for questions about the assignment. Office hours are available for questions about the assignment, as well.

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**QUESTION 1:**

The following question comes from the end of Chapter 8 on Cost-Benefit Analysis (Question 15) regarding the “Big Dig” highway and bridge construction project.

Imagine you are the governor of Massachusetts 15 years ago and need to decide if you should support the “Big Dig” highway and bridge construction project. The Big Dig is estimated to take seven years to complete. The project will require \$45 million in construction materials per year and \$20 million in labor costs per year. In addition, the construction will disrupt transportation within the city for the duration of the construction. The transportation disruption lengthens transport times for 100,000 workers by 30 hours per year. All workers are paid \$15 per hour (assume that there are no distortions and that the wage reflects each worker’s per-hour valuation of leisure). The Big Dig, when finished, will ease transportation within the city. Each of the 100,000 workers will have their transport time reduced by 35 hours a year as compared to the pre-construction transport time. In addition, part of the Big Dig project involves converting the space formerly taken up by an elevated highway into a large park. The Commonwealth of Massachusetts has determined that each worker will value the park at \$40 per year. We will assume that no one else will use the park.

We also assume the government has a 5% discount rate and that the workers live forever. The benefits to the Big Dig begin in year 7, assuming the project begins in year 0 (i.e., the project runs for 7 years, from  $t = 0$  to  $t = 6$ ).

- 1(a) Should the project be approved? Formally show the cost-benefit analysis.
- 1(b) Suppose that some of the cost estimates mentioned above are uncertain. Specifically, the construction materials estimate is \$45 million with 50% probability and \$100 million with 50% probability. Given these uncertainties, should the project proceed? (Assume that the government is risk neutral.)

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**QUESTION 2:**

The following question comes from the end of Chapter 8 on Cost-Benefit Analysis (Question 14) regarding “Jellystone National Park.”

Jellystone National Park is located 10 minutes away from city A and 20 minutes away from city B. Cities A and B have 200,000 inhabitants each, and residents in both cities have the same income and preferences for national parks. Assume that the cost for an individual to go to a national park is represented by the cost of the time it takes her to get into the park. Also assume that the cost of time for individuals in cities A and B is \$.50 per minute.

You observe that each inhabitant of city A goes to Jellystone ten times a year, while each inhabitant of city B goes only five times a year. Assume the following: the only

people who go to the park are the residents of cities A and B; the cost of running Jellystone is \$1,500,000 a year; and the social discount rate is 10%. Also assume that the park lasts forever.

- 2(a)** Compute the cost per visit to Jellystone for an inhabitant of each city.
- 2(b)** Assuming that those two observations (cost per visit and number of visits per inhabitant of city A, and cost per visit and number of visits per inhabitant of city B) correspond to two points on the same linear individual demand curve for visits to Jellystone, derive that demand curve. What is the consumer surplus for inhabitants of each city? What is the total consumer surplus?
- 2(c)** There is a timber developer who wants to buy Jellystone to run his business. He is offering \$100 million for the park. Should the park be sold?

### QUESTION 3:

The following question is based on Question 10 at the end of Chapter 8 on Cost-Benefit Analysis regarding “Gruberville.” Note that some elements of the question have been changed.

The city of Gruberville is considering whether to build a new public swimming pool. This pool would have a capacity of 1,000 swimmers per day. The estimated cost of the swimming pool, averaged over the life of the pool, is \$4 per swimmer per day. Gruberville has hired you to assess this project. Fortunately, the neighboring identical town of Figliona already has a pool, and the town has randomly varied the price of that pool to find how price affects usage. The results from their study follow (Table 1):

| WTP  | Quantity of Swimmers |
|------|----------------------|
| \$8  | 1,200                |
| \$10 | 800                  |
| \$4  | 2,000                |
| \$6  | 1,600                |
| \$2  | 2,400                |

Table 1: Estimated SMB of Swimming Pool

- 3(a)** What is the (maximum) entrance fee that would result in the swimming pool reaching the capacity of 1,000 swimmers?
- 3(b)** What is the consumer surplus (for swimmers) if a \$5 fee is charged?
- 3(c)** What would be the net-benefit per day from the swimming pool if a fee of \$5 is charged?
- 3(d)** What fee and capacity combination would maximize society’s net-benefit?
- 3(e)** If swimmers experienced “congestion” when entrance to the pool is free (fee = \$0), then how might this affect the SMB curve? (Hint: think of the congestion as a negative consumption externality that increases as the quantity of swimmers exceeds the capacity of 1,000.) How might this situation change your answer to Question (c)?

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**QUESTION 4:**

A public works project being considered for public funding has the following estimated costs and benefits. The relevant information is as follows:

- The projected time span of construction is 15 years ( $t = 15$ ).
  - The construction material costs are estimated to be \$300,000 per year, starting immediately.
  - The construction capital equipment (specialized machinery) will be purchased immediately ( $t = 0$ ) for \$200,000, and then will be liquidated for an estimated amount of \$50,000 at the end of the construction ( $t = 15$ ).
  - The construction will re-route traffic during rush-hours, causing commuter delays of 800 hrs per year for 2 million employed workers in the area.
  - The 2 million employed workers value their time at \$40/hr.
  - Use of the project by the citizens begins after the 15th year, and each of the 3 million households value the completed project at a uniform willingness to pay of \$10,000 per year.
  - The project is expected to bring an additional 5,000 tourists to the regional economy, each of which values the project enough to spend \$500/year in the regional economy.
  - The enjoyment of the project by tourists and citizens will continue indefinitely into the future.
  - The construction requires the employment of 100 workers, each of whom will receive a competitive market wage of \$40/hr for 2,500 hrs per year.
- 4(a) According to a net-present value calculation of this project, should it be done if the discount rate is 4%? Provide a description of your calculations.
- 4(b) According to a net-present value calculation of this project, should it be done if the discount rate is 8%?

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**QUESTION 5:**

Anna, Bill and John each value the public project of building new hospitals differentially. Anna has a demand for the public good  $Q_A = 50 - p$ , Bill's demand is  $Q_B = 60 - 2p$ , and John's demand is  $Q_J = 30 - (0.5)p$ . The marginal cost of providing hospitals is  $MC = 20$ .

- 5(a) What is the aggregate willingness to pay (social demand) for the public project? (Hint: it will be a piece-wise function defined over three ranges of  $Q$ .)
- 5(b) What is the socially optimal provision of the public good in this case?
- 5(c) Which share of the tax burden would each of three people pay under Lindhal pricing?
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**QUESTION 6:**

A town is deciding between alternatives on additional hospitals funding. There are four options which come with corresponding tax increases:  $H$  (highest level funding),  $M$  (medium level),  $L$  (low level) and  $N$  (no additional funding).

There are three groups of voters in the town. The first group is Elderly people who need hospital services most, the second group is Young people who need hospital services the least but also don't want the low quality hospitals for the future. The third group is Rich people who prefer to use medical care in other towns with better quality or to finance only high quality hospitals in home town. The preferences of three groups are summarized in the Table 2.

| Table 2: Preferences |     |       |      |
|----------------------|-----|-------|------|
|                      | Old | Young | Rich |
| 1st                  | H   | L     | N    |
| 2nd                  | M   | M     | H    |
| 3rd                  | L   | N     | L    |
| 4th                  | N   | H     | M    |

- 6(a)** What is the outcome of the pairwise majority voting in this town?  
**6(b)** Do the results of the majority voting satisfy transitivity? Is there an overall winner?  
**6(c)** Are preferences of the voters single-picked?
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**QUESTION 7:**

Reconsider the situation of Question 6: suppose now that, instead of the Rich group ( $R$ ), we have Middle-aged group ( $M$ ) with preferences specified in Table 3. Answer the following questions under these new preferences.

| Table 3: Preferences (2) |     |       |        |
|--------------------------|-----|-------|--------|
|                          | Old | Young | Middle |
| 1st                      | H   | L     | M      |
| 2nd                      | M   | M     | H      |
| 3rd                      | L   | N     | L      |
| 4th                      | N   | H     | N      |

- 7(a)** What is the outcome of the pairwise majority? Is there an overall winner?  
**7(b)** Who is the median voter in this case?  
**7(c)** Does the result of the median voter theorem hold in this case?