FINAL EXAMINATION
Networked Life (MKSE 112)
December 8, 2011
Prof. Michael Kearns

This is a closed-book exam. You should have no material on your desk other than the exam itself and a pencil or pen. If you run out of room on a page, you may use the back, but be sure to indicate you have done so.

Name: _____

Penn ID: _____

Problem 1: _____/10

Problem 2: _____/10

Problem 3: _____/10

Problem 4: _____/15

Problem 5: _____/10

Problem 6: _____/20

Problem 7: _____/10

Problem 8: _____/15

TOTAL: _____/100

Problem 1 (10 points) For each of the following statements, simply write "TRUE" or "FALSE".

a. The Price of Anarchy measures the extent to which a Nash equilibrium is better than the maximum social welfare solution.

b. In the behavioral experiments on biased voting, the well-connected minority tended to lose.

c. An edge always connects two vertices of equal degree.

d. The Marvel Comic Universe in some ways resembles a real social network.

e. A completely connected bipartite graph between Milks and Wheats may sometimes exhibit wealth variation at equilibrium.

f. If you know the Pageranks of all the pages that point to page P, and the Pageranks of all the pages that P points to, you can determine the Pagerank of P.

g. Segregation within a population can always be explained by strong discriminatory preferences of one of the types.

h. Low clustering coefficient and a heavy-tailed degree distribution are incompatible properties.

i. A monotone property of networks is one that can't go away by adding more edges to the network.

j. In the Erdos-Renyi model with N vertices, most interesting structural properties arise when p is approximately 1/sqrt(N).

Problem 2 (10 points) In lecture we discussed many real-world quantities whose empirical distributions exhibit long tails. Pick and discuss any such quantity *other* than degree distributions of networks. Be as precise as possible about exactly what quantity you are discussing, and give a clear description of the process by which you think it came to have long tails.

Problem 3 (10 points) The following output is the result of running the "traceroute" command demonstrated in class. Briefly but precisely describe what this command is doing, and what its output is showing. Discuss any organizational, business and geographical inferences you can make from this trace.

```
bash-3.2$ traceroute www.cs.stanford.edu
traceroute to cs.stanford.edu (171.64.64.64), 64 hops max, 52 byte packets
 1  seas-apn-gw.router.upenn.edu (158.130.104.1)  1.669 ms  1.028 ms  1.024 ms
 2  external3-core2.dccs.upenn.edu (128.91.10.2)  1.067 ms  5.897 ms  4.505 ms
 3  external-core1.dccs.upenn.edu (128.91.9.1)  1.367 ms  1.095 ms  1.136 ms
 4  local.upenn.magpi.net (216.27.100.73)  1.951 ms  2.613 ms  9.942 ms
 5  remote.internet2.magpi.net (216.27.100.54)  21.424 ms  11.438 ms  7.331 ms
 6  64.57.28.193 (64.57.28.193)  8.745 ms  11.784 ms  8.848 ms
 7  ae-8.10.rtr.atla.net.internet2.edu (64.57.28.6)  22.381 ms  24.723 ms  22.859 ms
 8  xe-1-0-0.0.rtr.hous.net.internet2.edu (64.57.28.112)  45.974 ms  59.457 ms  98.308 ms
 9  * * ge-6-1-0.0.rtr.losa.net.internet2.edu (64.57.28.96)  475.088 ms
10  hpr-lax-hpr--i2-newnet.cenic.net (137.164.26.133)  77.909 ms  77.845 ms  77.838 ms
11  svl-hpr2--lax-hpr2-10g.cenic.net (137.164.25.38)  86.509 ms  86.313 ms  91.700 ms
12  hpr-stanford--svl-hpr2-10ge.cenic.net (137.164.27.62)  86.844 ms  102.996 ms  104.788 ms
13  boundarya-rtr.stanford.edu (171.66.0.34)  172.854 ms  86.867 ms  86.742 ms
14  bbra-rtr.stanford.edu (171.64.255.129)  120.103 ms  89.006 ms  87.124 ms
15  yoza-rtr-a.stanford.edu (171.64.255.144)  87.040 ms  86.913 ms  87.120 ms
16  cs.stanford.edu (171.64.64.64)  87.844 ms  87.193 ms *
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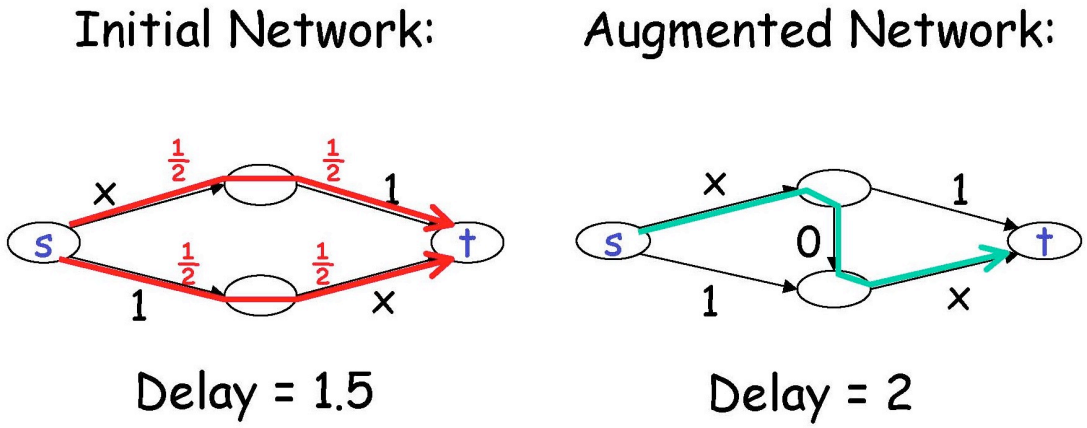
Problem 4 (15 points) In the first half of the class, we were primarily concerned with the dynamics of contagion in networks; in the second half, with "rational" dynamics. Write a brief essay in which you discuss the differences and similarities between the two. Be sure to give examples of each, and also to discuss the differing notions of outcome we employed in the analysis of each type of dynamics. You may want to refer to some of the course readings in your essay.

Problem 5 (10 points) The following diagram illustrates Braess' Paradox. Briefly but precisely describe what the figure is showing, and why there is a paradox. What implications might Braess' Paradox have for traffic management in large cities?



Problem 6 (20 points) Write 10 single sentences, each articulating a distinct principle, phenomenon or fact that you learned in this class. In addition to accuracy and clarity, your answers will be graded for their generality and their diversity.

Problem 7 (10 points) Clearly draw a connected, bipartite network between 4 Milk players and 4 Wheat players in which (a) there is wealth variation at equilibrium, but (b) there is a single edge whose addition eradicates wealth variation at equilibrium. Clearly annotate your diagram with the numerical wealths of all players for part (a), and with the added edge for part (b).

Problem 8 (15 points) The table below represents the payoffs for a two-player, one-shot, simultaneous move game of the type we considered in lecture.

	A	B
One	10, 10	1, 11
Two	11, 1	2, 2

(a) Is there a Nash equilibrium for this game? If so, what is it?

(b) What is the Price of Anarchy for this game?

(c) Changing only two numbers in the table, alter the payoffs so that the Price of Anarchy becomes as small as possible. Indicate the changes clearly on the diagram.