This final exam is worth 40% of your grade. You will only have one opportunity to take this exam.

Multiple Choice

(1.67/2 points)
SCENARIO: Suppose that there are three types of used cars—good ones, mediocre ones, and bad ones—and that each seller knows which type of car he or she has. Buyers do not know the type of car that any individual seller has; buyers will only know the type of any car after they buy it. The fraction of used cars that are good is 1/3, the fraction that are mediocre is 1/3, and the fraction that are bad is 1/3. Buyers know these fractions.

Let's suppose that a seller who has a good car values it at $8,000, a seller with a mediocre car values it at $6,000, and a seller with a bad car values it at $0. A seller is willing to sell his or her car for any price greater than or equal to the seller's value for the car; the seller is not willing to sell the car at a price below the value of the car. Buyers' values for good cars, mediocre cars, and bad cars are $14,000, $8,000, and $3,000, respectively. Let's assume that buyers are willing to pay their expected value of a car.

Social Contagion
Homework due Apr 26, 2016 at 19:00 UTC

Final Exam
Final Exam due May 03, 2016 at 19:00 UTC

▸ Course Survey

1. True or false: There is an equilibrium in the used-car market in which all types of used cars are sold.

- (•) True ✔
- ( ) False

2. True or false: There is an equilibrium in the used-car market in which good cars are not sold, but mediocre ones and bad ones are sold.

- ( ) True
- (•) False ✔

3. True or false: There is an equilibrium in the used-car market in which good and mediocre cars are not sold, but bad ones are sold.

- (•) True ✔
- ( ) False

SCENARIO: A seller is running a sealed-bid, second-price auction for a single item. Your private value for this item is $20. That is, you would be willing to pay as much as $20 for it, but you would not be willing to pay more than $20 for it. Three other bidders in the auction also have private values for the item. You do not know their values and they do not know your value. You, of course, know your own value for the item, and you do not directly care about their values for it. That is, even if you knew their values, you would still value the item at $20.

4. True or false: You should bid $20 for the item.

- (•) True ✔
- ( ) False

SCENARIO: Now, continuing this scenario, you discover that bidders 2 and 3 are in collusion. That is, they tell each other their values for the item (they don't lie to each other), and then they both bid the lower of the two values. Their plan is that if they win the item it will go to the one of them with the higher value. This bidder who gets the item will pay the seller the price determined by the second-price auction, and this bidder will pay the other bidder a fee for cooperating with him.

5. True or false: You should bid less than $20 for the item.

- ( ) True

- False ✔

SCENARIO: Now you discover that actually there is no real fourth bidder. Instead, the seller acts as the fourth bidder, but he bids only after seeing the real bids from the other three bidders. The seller looks at the three real bids and then, acting as bidder 4, he turns in a bid just below the highest of the three real bids (you can imagine that this fake bid from the seller is the highest bid minus the minimum possible increment, possibly one cent). Other than acting as a bidder after seeing the others' bids, the seller runs a second-price auction in the sense that the item is sold to the bidder with the highest bid at a price equal to the second-highest bid (which will be the seller's fake bid).

6. True or false: You should bid $20.

- True ✖
- False ✔

You have used 1 of 1 submissions

Multiple Choice

(4/4 points)

	L	R
U	2, 1	4, 3
M	1, 5	3, 4
D	4, 3	1, 1

Consider the two-player game shown here, in which the row player can play U, M, or D and the column player can play L or M. Answer the questions that follow.

7. True or false: In this game, the strategy M is a best response by the row player to a play of L by the column player.

- True
- False ✔

8. True or false: In this game, the strategy M is a best response by the row player to a play of R by the column player.

- ○ True
- ◉ False ✔

9. True or false: In any pure-strategy Nash equilibrium for this game, the row player does not play M.

- ◉ True ✔
- ○ False

10. True or false: This game has a Nash equilibrium in which the row player plays D and the column player plays L.

- ◉ True ✔
- ○ False

11. True or false: This game has a Nash equilibrium in which the row player plays U and the column player plays R.

- ◉ True ✔
- ○ False

12. This game has a mixed-strategy equilibrium and we want to know the probability for the following. The row player plays:

U with probability ____

- ○ 0
- ○ .1
- ○ .4
- ◉ .5 ✔
- ○ .6

M with probability ____

- [x] 0
- [ ] .1
- [ ] .4
- [ ] .5
- [ ] .6

D with probability ____

- [ ] 0
- [ ] .1
- [ ] .4
- [x] .5
- [ ] .6

The column player plays L with probability ____

- 0
- .1
- .4
- .5
- .6 ✔

You have used 1 of 1 submissions

Multiple Choice

(4/4 points)
SCENARIO: Let's consider a good that has network effects as we discussed in the course. Consumers of this good are named using real numbers between 0 and 1. Each consumer wants to buy at most one unit of the good. The reservation price for consumer x when a z

fraction of the population uses the product is given by the formula r(x) f(z), where r(x) = (1 - x). The function f(z) reflects two competing forces. First, up to fraction one-half of the population buying the good, having more people buy the good increases the amount that each person is willing to pay for it. To model this effect, we assume that f(z)= 4z for z between 0 and 1/2. Second, if more than one-half of the population buys the good, then having even more people buy the good reduces the amount that each person is willing to pay for it. To model the effect, we assume that f(z)=4-4z for z between 1/2 and 1. Suppose that the good is sold at a price of 1/4.

13. True or false: No one buying the product (z=0) is an equilibrium. Note that here we are checking whether z=0 is an equilibrium, so z is less than one-half, and in this region rf=4z(1-z).

- (●) True ✔
- ( ) False

14. True or false: One-half of the population buying the product (z=1/2) is an equilibrium. Note that as we are checking z=1/2, we have 4z=4-4z=2, and so you can use either branch (4z or (4-4z)) of the function f.

- ( ) True
- (●) False ✔

15. True or false: Three-fourths of the population buying the product (z=3/4) is an equilibrium. Note that here we are checking whether z=3/4 is an equilibrium, so z is greater than one-half, and in this region rf=(1-z)(4-4z).

- (●) True ✔
- ( ) False

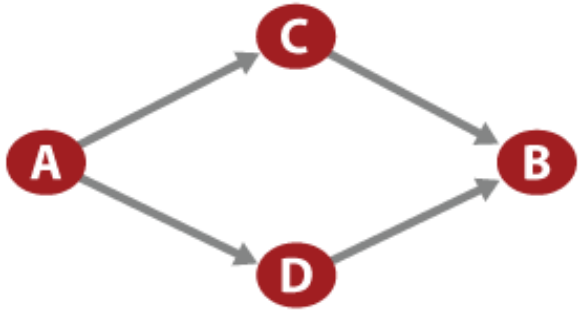
16. There is an equilibrium fraction of the population using the product that is greater than one-half. Let's call this fraction z'. Since z'>1/2, we are in the region where f(z)=4-4z. True or false: This equilibrium is unstable.

- ( ) True
- (●) False ✔

You have used 1 of 1 submissions

Multiple Choice

(1/1 point)



Consider the traffic network shown. Suppose the delay in hours on edge A-C with x travelers using the edge is x/100, the delay on edge C-B is 1 hour, the delay on edge A-D is 3 hours, and the delay on edge D-B with y travelers using the edge is y/200 hours.

17. Suppose 200 travelers want to get from A to B, and they are all using the route A-C-B. True or false: This is an equilibrium.

- (●) True ✔
- ( ) False

18. Supposing now that traffic increases to 350 travelers, find the equilibrium split of traffic between the two routes. What is the number of travelers using A-D-B?

- ( ) 0

- 50
- 100 ✔
- 150
- 200
- 250

What is the number of travelers using A-C-B?

- 0
- 50
- 150
- 200

- (•) 250 ✔
- ( ) 300

19. Now consider adding a directed edge A-B, with travel time z/100 if z travelers use the edge. What is the equilibrium split of traffic with the new edge? What is the number of travelers using A-D-B?

- (•) 0 ✔
- ( ) 25
- ( ) 50
- ( ) 75
- ( ) 100

What is the number of travelers using A-C-B?

- 50
- 75
- 100
- 125 ✔
- 150
- 175
- 200

What is the number of travelers using the direct edge A-B?

- 0
- 100
- 150

- 200
- 225 ✔
- 250
- 275

You have used 1 of 1 submissions

Multiple Choice

(7.33/8 points)

SCENARIO: Suppose a search engine has two ad slots that it can sell: slot a and slot b. Slot a has a click-through rate of 10, slot b has a click-through rate of 8. There are three advertisers who are interested in these slots. Advertiser x values clicks at 5 per click, advertiser y values clicks at 7 per click, and advertiser z values clicks at 9 per click.

20. Suppose the search engine uses a GSP auction to decide which advertiser gets each slot. Assume for now that each advertiser bids their true value for the slot in this auction. Which advertiser will get each slot, and how much will they pay for each click they get?

Slot a goes to which advertiser?

- X
- Y
- Z ✔

What is the cost per click?

7 ✔

Answer: 7

7

Slot b goes to which advertiser?

- X
- Y ✔
- Z

What is the cost per click?

5 ✔

Answer: 5

5

21. Is truthful bidding equilibrium in this GSP auction?

- Yes
- No ✔

22. Which bidder can improve her value by bidding differently?

- X
- Y
- Z ✔

23. In that scenario, what should she bid?

- Any number between 1 and 3
- Any number between 3 and 5
- Any number between 5 and 7 ✔
- Any number between 7 and 9 ✖

24. Now suppose that the search engine uses the VCG mechanism to decide which advertiser gets each slot. Is bidding their true values an equilibrium for the advertisers in the VCG mechanism?

- Yes ✔
- No

25. In the VCG mechanisms, consider which advertiser will get each slot.

Slot a goes to which advertiser?

- X
- Y
- Z ✔

What is the cost per click? (Frame your answer to one decimal place, as "X.X.")

5.4 ✔

Answer: 5.4

5.4

Slot b goes to which advertiser?

- X
- Y ✔
- Z

What is the cost per click?

5.0 ✔

Answer: 5

5.0

You have used 1 of 1 submissions

Multiple Choice

(4/4 points)

Buyer:	Value for A	Value for B	Value for C
X	1	3	2
Y	3	0	1
Z	2	1	1

Three buyers, X, Y, and Z, are each considering buying one of three houses, A, B, and C. Their valuations for the houses are given in the table shown.

26. Is there a set of market-clearing prices where only one house has a non-zero price?

- (•) Yes ✔
- ( ) No

27. Assume there is a set of market-clearing prices where only one house has a non-zero price. Which house must have a non-zero price in this situation?

- (•) house A ✔
- ( ) house B
- ( ) house C

Which is a possible value for this non-zero price?

- ( ) 0.5
- (•) 2 ✔

- 3

Who will buy house A?

- X
- Y ✔
- Z

Who will buy house B?

- X ✔
- Y
- Z

Who will buy house C?

- X
- Y
- Z ✔

28. Consider the set of prices where the prices of houses A and C are 1, and the price of house B is 0. Is this set of prices market clearing?

- Yes
- No ✔

29. You observed that the market cleared at the prices suggested in the previous question (prices of houses A and C are 1, the price of house B is 0), and we suppose that X got house C. You realize that buyer X's value for house C in the above table is not correct. What is the lowest possible value X may have for house C to make these prices market clearing (assuming all other values in the table are correct)?

- 2
- 3
- 4 ✔
- 5
- 6

You have used 1 of 1 submissions

Multiple Choice

(3/3 points)

SCENARIO: Suppose people are sequentially making decisions about whether or not to adopt a product. Assume that the product is good with probability ½, and bad with probability ½. Each person gets a signal independently about the quality of the product. For a good product, the signal is H with probability 3/5, and L with probability 2/5. For a bad product, the signal is L with probability 3/5, and H with probability 2/5. Each person gets a reward of +1 for accepting a good product, and a cost of -1 for accepting a bad product. Each person in turn observes the decisions, but not the signals of the previous people.

30. Suppose the first four people get L, H, H, H signals in this order. What will each of them decide? (Recall that we assumed that in case a person is neutral based on information they can infer, they will follow their own signal.)

Does person 1 accept or reject?

- ○ Accept
- ◉ Reject ✔

Does person 2 accept or reject?

- ◉ Accept ✔
- ○ Reject

Does person 3 accept or reject?

- ◉ Accept ✔
- ○ Reject

Does person 4 accept or reject?

- (•) Accept ✔
- ( ) Reject

31. Now suppose the product is bad. What is the probability of the first four people getting signals L, H, H, H in this order? (Enter your response as a fraction.)

24/625 ✔

$\frac{24}{625}$

32. What is the probability that the product is bad given the sequence of signals L, H, H, H? (Enter your response as a fraction.)

4/13 ✔

$\frac{4}{13}$

33. Suppose now that the 5th person gets signal L. Will person 5 accept or reject?

- (•) Accept ✔
- ( ) Reject

You have used 1 of 1 submissions

Multiple Choice

(2/3 points)
SCENARIO: A social networking site is studying how new applications (apps) spread from one country to another. In particular, they're trying to understand the following phenomenon that takes place between two neighboring countries, which we'll call A and B. The site has 10 million users in each country, and to make the question easy to express, we'll assume that the friendships among these users have the following simple structure.

Each user in A has 40 friends: 30 of these friends are also in A, and 10 of them are in B.

Each user in B has 30 friends: 20 of these friends are also in B, and 10 of them are in A.

The site's administrators have observed the general principle that a user will tend to start using a new app on her own (without any additional marketing from the site) according to a threshold rule: She will start using it once at least a q fraction of her friends have started using

it. But thus far they have not been recording the exact time when people started using various apps (they only compile usage information for their apps every month), and so they are not sure what this value of q is.

An app X began in country A, and spread so that everyone in A is using it, then stopped spreading and didn't spread to the users in country B. The site manager is trying to use the observation above to estimate the value of q.

34. What can the manager conclude about the possible range of q? (Enter your responses as decimals in the format X.XX.)

q is greater than:

1/3 ✖

Answer: 0.33

$\frac{1}{3}$

q is less than:

3/4 ✔

Answer: 0.75

$\frac{3}{4}$

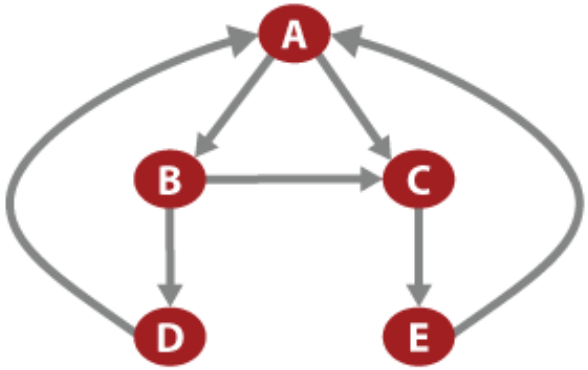
35. Now let's assume a technology is spreading in country B, but that it has not yet spread to country A. Given what you learned about the value of q from the first technology, do you expect this technology to spread to country A?

- Yes
- No ✔

You have used 1 of 1 submissions

Multiple Choice

(5/5 points)



36. What is the page rank of each node in the network of web pages shown?

PR(A) =

- 1/13

- 2/13
- 3/13
- 4/13 ✔

PR(B) =

- 1/13
- 2/13 ✔
- 3/13
- 4/13

PR(C) =

- 1/13

- 2/13
- 3/13 ✔
- 4/13

PR(D) =

- 1/13 ✔
- 2/13
- 3/13
- 4/13

PR(E) =

- 1/13

- 2/13
- 3/13 ✔
- 4/13

37. Now suppose a link is added from page E to page D. What are the new PageRank values?

PR(A) =

- 4/29
- 5/29
- 6/29
- 8/29 ✔

PR(B) =

- ◉ 4/29 ✔
- ○ 5/29
- ○ 6/29
- ○ 8/29

PR(C) =

- ○ 4/29
- ○ 5/29
- ◉ 6/29 ✔
- ○ 8/29

PR(D) =

- 4/29
- 5/29 ✔
- 6/29
- 8/29

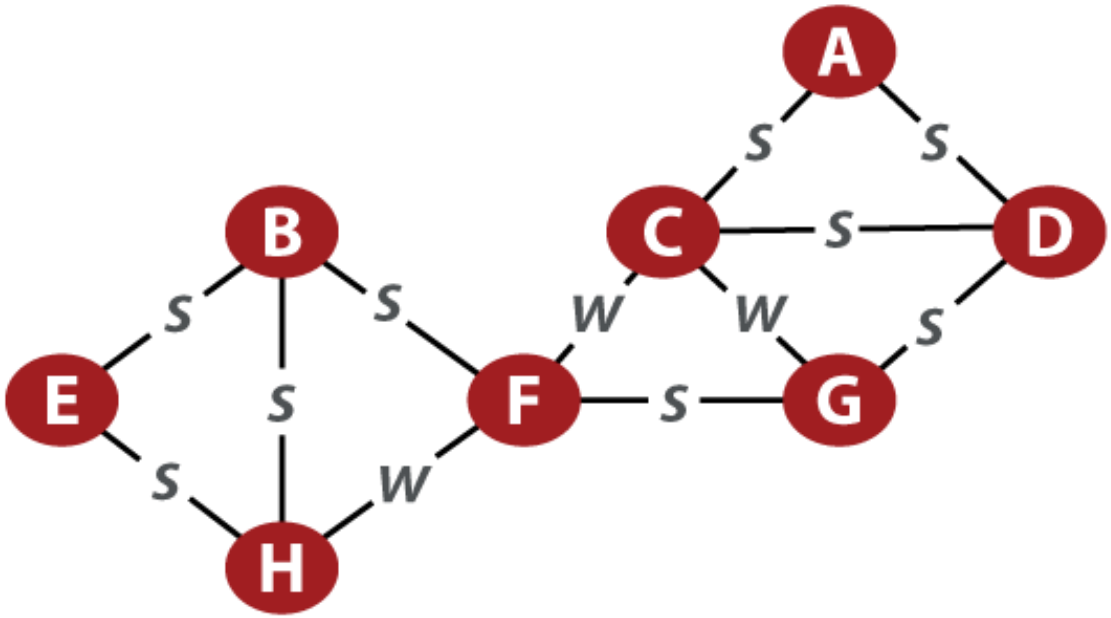
PR(E) =

- 4/29
- 5/29
- 6/29 ✔
- 8/29

You have used 1 of 1 submissions

Multiple Choice

(3/3 points)



38. In the social network shown, some nodes are labeled as strong ties (S) and some are labeled as weak ties (W). Which nodes violate the strong triadic closure property? (Select all that apply.)

- [ ] A
- [x] B
- [ ] C

- [x] D
- [ ] E
- [x] F
- [x] G
- [ ] H

✔

39. Suppose you were to add a strong tie from B to C. After the addition of this edge, would the number of nodes that violate the strong triadic closure property increase, decrease, or remain the same?

- ○ Stay the same
- ○ Decrease
- ◉ Increase ✔

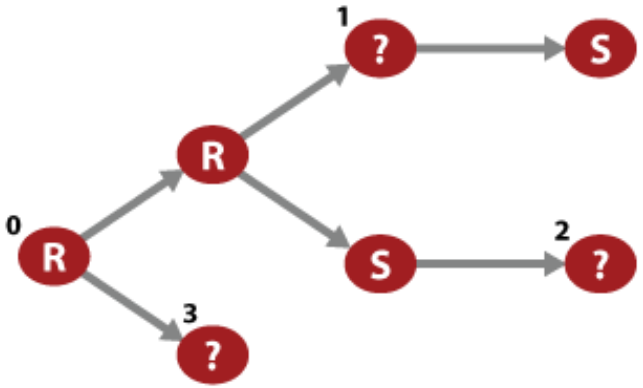
40. Suppose you were to add a weak tie from A to G. After the addition of this edge, would the number of nodes that violate the strong triadic closure property increase, decrease, or remain the same?

- Stay the same
- Decrease ✔
- Increase

You have used 1 of 1 submissions

Multiple Choice

(3/3 points)



41. Suppose you are helping a team of public health workers track the course of a new disease in its first days. They are representing the disease as an S.I.R. epidemic spreading on a graph, and the initial course of the disease is depicted in the network shown.

Of the seven nodes shown in the network, it is known that the disease began with the node labeled 0: at the start, node 0 was in the infectious state, and all other nodes were susceptible. As time passed, all further cases of the disease were caused by contagion across links of this network. The network shown in the figure is labeled with the states of the nodes at the current point in time, a little while after node 0 first became sick with the disease. The public health workers know the current state of four of the seven nodes, but do not know the states of the nodes labeled 1, 2, or 3. They would like your help in reasoning about the possible states of these nodes.

For each of the nodes labeled 1, 2, and 3, the question is whether you can tell for sure which state they are in, or whether there is not enough information to tell. In particular, for each of nodes 1, 2, and 3, provide one of the following four possible answers: the node is in state S, the node is in state I, the node is in state R, or there is not enough information to tell for sure which state the node is in.

Node 1 would be:

- S
- I
- R

- (•) Not enough information to tell ✔

Node 2 would be:

- (•) S ✔
- ( ) I
- ( ) R
- ( ) Not enough information to tell

Node 3 would be:

- ( ) S
- ( ) I
- ( ) R

- ◉ Not enough information to tell ✔

You have used 1 of 1 submissions