SI 301
Sample Midterm Exam 1

Name: _____ **Score:** /100

1. Consider the network in figure 1.
   a. Is the graph connected? Explain. (1 point)
   b. Compute the clustering coefficient of nodes A, B, and H. (3 points)
   c. Compute the distance between nodes H and K. (1 points)
   d. How many connected components does the network have? (1 points)
   e. Identify all bridges and local bridges (2 points)
   f. Identify the longest cycle in the network. (1 points)
   g. Is the graph bipartite? Explain. (1 points)
   h. Is the graph complete? Explain. (1 points)

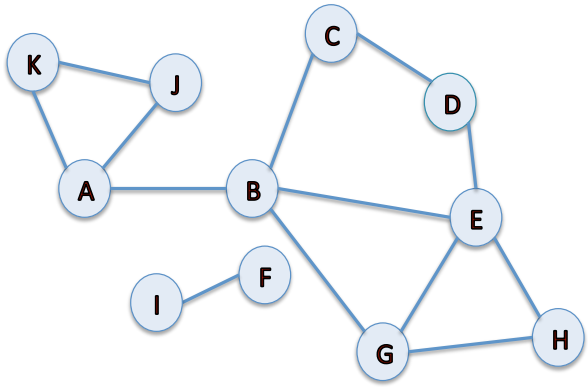

Figure 1

2. Consider the network in figure 2, where each edge has a label indicating whether the edge is a weak (w) or strong (s) tie.
   a. Which nodes violate the Strong Triadic Closure Property? (5 points)
   b. Change the label of at most 2 edges so that all nodes satisfy the Strong Triadic Closure Property. (3 points)

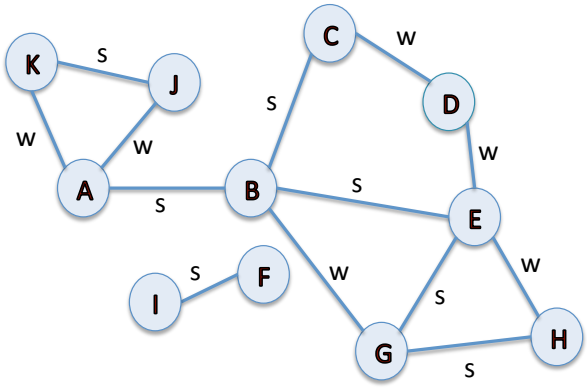

Figure 2

3. In class we proved that if a node A in a network satisfies the Strong Triadic Closure property and is involved in at least two strong ties, then any local bridge A is involved in must be a weak tie. We informally summarized this claim as "local bridges are usually weak ties." Explain the relationship between this claim and Granovetter's findings about the role of weak ties in job seeking. (8 points)
4. Consider the social-information network in figure 3, which represents friendships between students (blue edges) and the students' major (green edges).
    a. Label the edges of the network such that the label indicates the ordering in which the edges formed. Label the first edge that formed with a "1", the second edge that formed with a "2", and so on. Assign the labels such that the evolution of the network is more consistent with the mechanism of selection rather than social influence. (5 points)
    b. Briefly explain why the ordering you provided is more consistent with selection than social influence. (5 points)

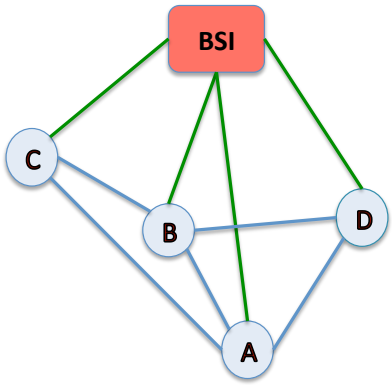

Figure 3

5. Give an example of a complete four-node network with at least one positive and one negative edge such that the network satisfies the Weak Structural Balance Property but not the Structural Balance Property. (10 points)
6. Give an example of a two-player game where one player has a dominant strategy and the other player does not. It is enough to show the payoff matrix and indicate which player has a dominant strategy. (10 points)
7. Consider the payoff matrix below:
    a. Find all Nash equilibria in the game. [Hint: this game has both pure-strategy and mixed-strategy Nash equilibria]. Show your work. (10 points)
    b. Find the socially optimal strategy. (3 points)

		Player B	
		Q	**T**
Player A	**R**	0, 0	2, -2
	U	-1, 1	3, 2

8. Consider a second-price sealed-bid auction with 3 bidders, A, B, and C. Assume that bidder A has a private value of 2 and bidders B and C have independent, private values that are either 1 or 3. For bidders B and C, the probability of having private value of 1 is ½ and the probability of having private value of 3 is also ½. If bidders bid according to their dominant strategies, what's the seller's expected revenue? Show your work. (10 points)
9. For each of the following statements, state whether the statement is true or false. You do not need to explain your answer. (2 points each)
    a. All bridges are local bridges, but not all local bridges are bridges.
    b. All bipartite graphs are connected, but not all connected graphs are bipartite.
    c. Global clustering coefficient is a measure of the presence of triadic closure in a network.
    d. Local bridges are always weak ties by definition.
    e. In Milgram's Small-world experiment, all starter letters reached the target and the median chain length was 6.
    f. All networks that satisfy the Structural Balance Property satisfy the Weak Structural Balance Property, but not all networks that satisfy the Weak Structural Balance Property satisfy the Structural Balance Property.
    g. Nash equilibria have the nice property that they are always socially optimal.
    h. All games with two players and two strategies per player have at least one pure-strategy Nash equilibrium.
    i. In a second-price sealed-bid auction, bidding your true value is a dominant strategy.
    j. In a third-price sealed-bid auction, where the buyer with the highest bid buys the item and pays the third highest bid, bidding your true value is a dominant strategy.