SI 301
Sample Midterm Exam 2

Name: _____ **Score:** /100

1. Consider the network in figure 1.
    a. Is the graph connected? Explain. (2 points)
    b. Compute the clustering coefficient of nodes D, J, and G. (1 point)
    c. Compute the distance between nodes H and G. (1 point)
    d. Identify all local bridges and their span. (3 points)
    e. Compute the neighborhood overlap of the edge E—H. (1 point)
    f. Compute the embeddedness of the edge E—H. (1 point)
    g. What is the diameter of the network? Explain. (1 point)

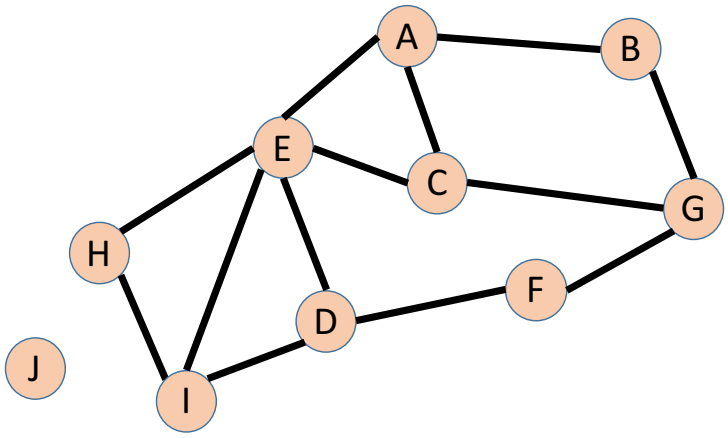

Figure 1

2. For each of the following, give an example of a network that satisfies the properties:
    a. The network has at least 10 nodes and has 3 connected components. (2 points)
    b. The network contains at least 5 nodes and is not bipartite. (3 points)
    c. The network has at least 4 nodes, is signed, is complete, and is neither balanced nor weakly balanced. (5 points)

3. Consider the network shown in figure 1.
    a. Label each edge in the network as strong (s) or weak (w) such that every node (except node J) has at least 1 strong edge and every node satisfies the Strong Triadic Closure property. (7 points)
    b. In part (a) you should have labeled at least one local bridge as "strong". Explain why this does not contradict the theorem we proved in class that states that under certain conditions local bridges are weak. [Hint: Think about whether all assumptions of the theorem are satisfied]. (3 points)

4. Consider the network shown in figure 2. The nodes represent children in a classroom and the edges represent friendships. The green nodes (labeled "A" through "H") prefer to play basketball and the orange nodes (labeled "I through "P") prefer to play soccer. Using the Homophily Test, determine whether there is evidence of homophily in this network. Show all your work. (10 points)

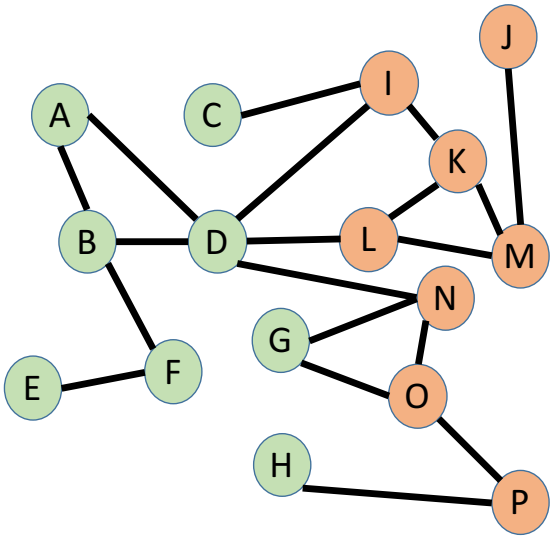

Figure 2

5. Recall that social-affiliation networks contain two types of edges: (i) edges between people and groups they are affiliated with and (ii) edges between people who have social relationships.
    a. Name and describe the different types of closure that are possible in social-affiliation networks. (3 points)
    b. Name and describe two different mechanisms that can drive homophily in social networks. For each mechanism, say which type of social-affiliation closure identified in part (a) is consistent with it. (7 points)

6. Consider the payoff matrix below:
    a. Does either player have a dominant strategy? Explain (2 points)
    b. What is the best response by player A to strategy Q? Is it a strict best response? Explain. (2 points)
    c. Find all Nash equilibria (Remember that a game can have both pure and mixed strategy Nash equilibria). Show all your work. (10 points)

		Player B	
		Q	**T**
Player A	**R**	0, -1	1, -2
	U	-3, 0	4, 3

7. Show the payoff matrix of a game that does not have a pure strategy Nash equilibrium (you do not need to find the mixed-strategy Nash equilibrium). (6 points)

8. In a fourth-price sealed-bid auction, where the buyer with the highest bid buys the item and pays the 4^{th} highest bid, is bidding your true value always a dominant strategy? If so, provide a proof. If not, give an example of a set of bidders and their true values, and identify at least one bidder who would have better payoff by placing a bid that is different from their true value. (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 local bridges are bridges, but not all bridges are local bridges.
    b. The diameter of a network is always at least as large as the number of edges in the largest cycle that the network contains.
    c. In a network that has its edges labeled as weak or strong, it's impossible make a node, which currently satisfies the Strong Triadic Closure property, violate the property by switching some of its strong ties (if any) to weak ties.
    d. Triadic closure states that whenever two people have a friend in common, they will eventually become friends.
    e. Transitivity weights the local clustering coefficient of nodes with a large number of connections more than that of nodes with a small number of connections.
    f. A signed, complete network that contains only negative edges is weakly balanced.
    g. If the nodes of a complete, signed network can be divided into 4 non-overlapping groups such that there are only positive edges within each group and only negative edges across groups, then the network is not structurally balanced.
    h. Every game with a finite set of players and strategies contains at least one Nash Equilibrium.
    i. A game with two players and two strategies per player, where one of the players has a strictly dominant strategy, always has a pure strategy Nash equilibrium.
    j. In a game with two players and two strategies per player, where both players have a strictly dominant strategy, the pair of strategies that consists of both players choosing their strictly dominant strategy is socially optimal.