

**August 2021: END SEMESTER ASSESSMENT, CSE, VI SEMESTER**

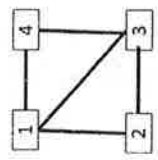
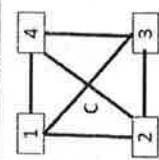
**UE18CS346–SOCIAL NETWORK ANALYTICS**

Time: 3Hrs.

Answer All Questions

Max Marks: 100

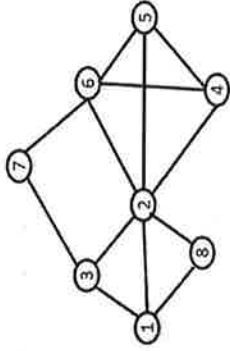
Provide full calculation for the numerical problems. No additional part marking will be done.

1	a)	<p>The question below has one correct answer. In your answer script, write your <u>chosen correct answer and option with reason in 1-3 sentences:</u></p> <p>I. In the matrix <math>B=A^4</math> when <math>A</math> is the adjacency matrix, <math>B_{ij}=16</math> for nodes <math>i</math> and <math>j</math> . This represents (a) 16 paths of length 4 (b) 4 paths of length 16</p> <p>II. A local bridge in a social graph is removed. It will (a) partition the graph into separate components (b) increase the distance between some previously connected nodes</p> <p>III. In a small graph of 3 nodes 1,2 and 3, the edges are <math>1 \rightarrow 2</math>, <math>2 \rightarrow 3</math>, <math>3 \rightarrow 1</math>, <math>1 \rightarrow 3</math> . The reciprocity of this graph is (a) <math>1/2</math> (b) 0</p>	3*2
	b)	<p><u>Provide necessary explanation with reasons in maximum 4 sentences for each statement :</u></p> <p>(a) In a star shaped graph of 100 nodes, you cannot find a 2-core subgraph</p> <p>(b) In an ego network, lack of ties among the alters will benefit the ego</p>	2*2
	c)	<p>In the network graph shown on the left, calculate</p> <p>(a) Global Clustering coefficient</p> <p>(b) Local clustering Coefficient at node 1</p> <p>(c) What is the difference of these two types of clustering coefficient ?</p> 	3*2
	d)	<p>In the Figure given, calculate the betweenness centrality of the <b>node C</b> at the center .</p> 	4
2	a)	<p><u>The question below has one correct answer. In your answer script, write your <u>chosen correct answer and option with reason in 1-3 sentences:</u></u></p> <p>I. In your class of boys and girls , <math>1/4</math> fraction is boy and cross gender friendship is <math>13/24</math> . It shows evidence of (a)homophily (b) inverse homophily</p> <p>II. If you compare Watts and Strogatz Small World model with Barabassi Albert Preferential Model , (a) BA exhibits power law in degree distribution but small world does not (b) Small World exhibits power law in degree distribution but BA model does not</p>	2*2

b)	<p><b><u>Provide necessary explanation with reasons in maximum 4 sentences for each statement :</u></b></p> <p>I. If we compare the log-log plot of degree distributions by Power law and Random Graph model of a large population, there is a difference in the tail of the graphs</p> <p>II. In an Erdos Renyi <math>G(n,p)</math> Random Graph Model, the local and global clustering coefficient is the same. Assume global clustering coefficient is the average of local clustering coefficient of all nodes.</p>	2*3
c)	<p>Given a random graph of 1000 nodes where each of the possible edges is present with probability 0.1. Let <math>N_1</math> be the number of nodes with the least degree and <math>N_2</math> be number of nodes with the highest degree. Let <math>N_3</math> be the number of nodes with median values of degree. Answer the following</p> <p>I. Why <math>N_1 &lt; N_3</math> and <math>N_2 &lt; N_3</math> in this case?</p> <p>II. Assuming that the graph exactly simulates World Wide Web and is not a generated random graph. What should be the corrected form of "<math>N_1 &lt; N_3</math> and <math>N_2 &lt; N_3</math>" in this case and why ?</p>	2+3
d)	<p>In a <math>G(n,p)</math> model where number of nodes is 10 and probability that any of the edges can be formed is 0.2. What is the expected number of edges in this ? What is the probability that a given node in the above graph has degree 5 ?</p>	2+3
3 a)	<p><b><u>The question below has one correct answer. In your answer script, write your chosen correct answer and option with reason in 1-3 sentences:</u></b></p> <p>I. The term <math>p(1-F(t-1))</math> in the bass model difference equation represents number of remaining members in the population who (a) will imitate the innovators (b)spontaneously adopt the innovation</p> <p>II. For a closed population, you are modelling an epidemic that eventually died out. You will use (a) SIR (b) SIS</p>	2*2
b)	<p><b><u>Provide necessary explanation with reasons in maximum 4 sentences for each statement :</u></b></p> <p>I. Modularity Optimization as used by Clauset, Newman and Moore as well as Louvain method of community detection is essentially a hill climbing algorithm</p> <p>II. While using Clique Percolation Method (CPM) for community detection, we usually try with small value of clique size <math>k</math></p>	2*3

c)

For the given graph, find communities and overlapped communities of size **greater than or equal to 3** using Clique Percolation Method (CPM).



Show matrix computation.

4

d)

Using SIR epidemic model, you are modeling Covid 19 epidemic for your city about which all the statistics are known. All usual assumptions are made i.e. the population can only be in one of the three states of SIR, it is a closed community, no reinfection and total recovery.  $S(0)$  is the number of susceptible,  $I(0)$  is the number of infected,  $R(0)$  is the number of recovered at  $t=0$ .  $\beta$  is the effective infection rate and  $\gamma$  is the effective recovery rate. The model equations for a particular time instant  $t$  are provided as below:

$$\frac{dS}{dt} = -\beta SI$$

$$\frac{dI}{dt} = \beta SI - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

$$S(t=0) = 200,000; I(t=0) = 200; R(t=0) = 10; \beta = .0001; \gamma = \frac{1}{25}$$

3+3

- (a) What should have been the threshold condition for the epidemic neither to grow nor to shrink ?  
 (b) What will be the number of susceptible, infected and recovered at  $t=1$  ?

4

a)

In the Game table on the left, assume that both players know the value of  $x$ , and both know that they know, and so on.

Row Player	Column Player	
	L	R
	U 1,2 D 3,0	0,1 $x,1$

2\*2

Explain for **what values of  $x$** (if any), strategy R for Column Player **may or may not** lead to iterated deletion of strictly dominated strategies ?

b)

(a) Does either player has a dominant or dominated strategy ?

(b) Find the equilibrium for this game

Player 1 Strategy	Player 2		
	Left	Middle	Right
Up	1,2	3,5	2,1
Middle	0,4	2,1	3,0
Down	-1,1	4,3	0,2

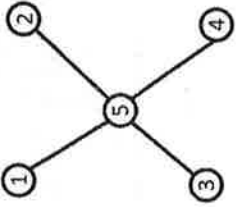
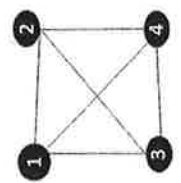
3+2

c)

Two criminals are thinking about pulling off a bank robbery. The take from the bank would be \$20,000 each, but the job requires two people (one to rob the bank and one to drive the getaway car). Each criminal could instead rob a liquor store. The take from robbing a liquor store is only \$1000 but can be done with one person acting alone.

- (a) How many equilibria are there for this game ?  
 (b) Show that the game is symmetric i.e. player A and Player B adopt the same strategies.

2+3

d)	<p>A player has three possible venues to choose from: going to a football game, going to a boxing match, or going for a hike. The payoff from each of these alternatives will depend on the weather. The table on the left gives the agent's payoff in each of the two relevant weather events. Let <math>p</math> denote the probability of rain.</p> <table border="1"> <thead> <tr> <th>Alternatives</th><th>Payoff if it rains</th><th>Payoff if it shines</th></tr> </thead> <tbody> <tr> <td>Football game</td><td>1</td><td>2</td></tr> <tr> <td>Boxing Match</td><td>3</td><td>0</td></tr> <tr> <td>Hike</td><td>0</td><td>1</td></tr> </tbody> </table> <p>(a) Is there an alternative that a rational player will never take regardless of value of <math>p</math> ?</p> <p>(b) What is the best response considering the probability <math>p</math> ?</p>	Alternatives	Payoff if it rains	Payoff if it shines	Football game	1	2	Boxing Match	3	0	Hike	0	1	2+4
Alternatives	Payoff if it rains	Payoff if it shines												
Football game	1	2												
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Hike	0	1												
5 a)	<p>Which auctions mentioned below are Pareto Efficient ? Answer this by defining Pareto Efficiency of auction.</p> <p>a) English Auction with no Reserve Price</p> <p>b) English Auction with Reserve Price</p> <p>c) Sealed bid first price auction</p>	3*2												
b)	<p>Player A is looking forward to buy an item that he values at \$80 in a second price sealed bid auction. Player B is also bidding in this auction and has a valuation of 90\$. Indicate <b>payoff of A and B</b> in the following cases:</p> <p>(a) A bids for 90\$ and B bids for 80\$</p> <p>(b) A bids for 80\$ and B bids for 90\$</p>	2*2												
c)	<p>Consider the star network given with the parameters given as</p> <ul style="list-style-type: none"> <li>- <b>utility or payoff</b> to a node from a formed link is 0.15 unit</li> <li>- <b>cost of forming a direct link</b> is 0.16 unit. Comment on the followings:</li> </ul> <p>(a) Which nodes are getting positive utility in this case ?</p> <p>(b) Is the network socially efficient ?</p> <p>(c) Is the network pairwise stable ?</p> 	3*2												
d)	<p>In the given co-authorship network for strategic model of network formation,</p> <p>(a) calculate the payoff for each node clearly showing the calculation.</p> <p>(b) Is this network pairwise stable ?</p> 	3+1												