

QUIZ 1 (Set IV)

Dynamical processes in complex networks
(Full marks: 20)

January 29, 2024

Question 1 [2+1=3 Marks]

For a star graph with $N = 5$ nodes, what is the average path length of the graph? What is the diameter of the graph?

Question 2 [2+1=3 Marks]

For the graph given in Figure 1, calculate the clustering coefficients of the nodes labelled X and Y .

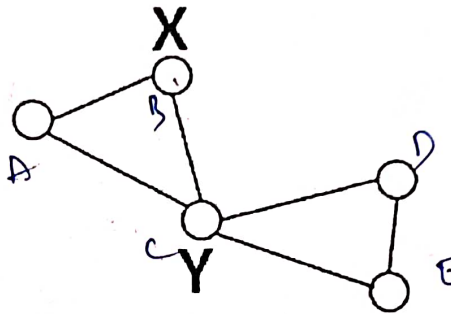
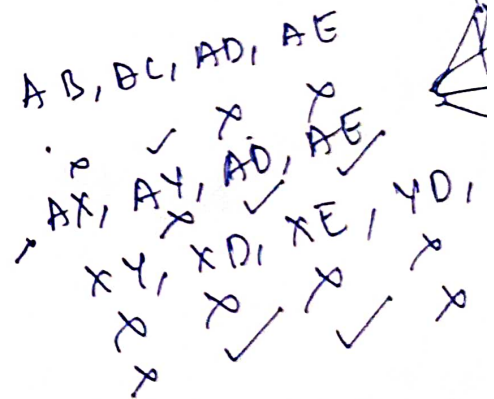


Figure 1

In reference to this graph, which statements are correct?

- (a) Degree of Y is greater than X .
- (b) Node betweenness of X is greater than Y .
- (c) Closeness centrality of X is smaller than Y .



Question 3 [2+2=4 Marks]

Calculate the (a) node betweenness and (b) closeness of nodes labelled X and Y in the graph in Figure 2.

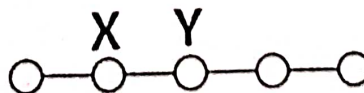


Figure 2

clustering
node

✓ Question 4 [1+1+2=4 Marks]

What is the main difference between a Eulerian path and a Hamiltonian path of a graph?

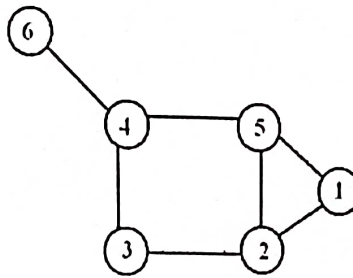


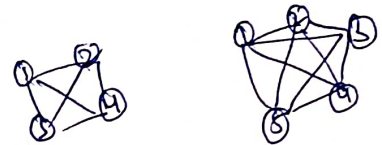
Figure 3

In the graph given in Figure 3, is there any Hamiltonian path/ Eulerian path/ Eulerian cycle? justify your answer. If not, how can you make an Eulerian path?

✓ Question 5 [2 Marks]

For an all-to-all connected network (binary, undirected, without self-loops) with number of nodes N , which of the following is/are true?

- ✓ (a) Network is symmetric.
- (b) Diameter of the network is N .
- (c) Average path length of the network is 1.
- (d) Average degree of the network $N - 1$.



Select the right option(s) and provide a one-line reasoning for why EACH of the options were correct or incorrect. Only attempting the options will NOT fetch any marks.

✓ Question 6 [2 Marks]

Given a probability (denoted by p) representing the likelihood of a connection between two nodes or the ratio of existing links to the total potential edges, what is the relationship between p , the average degree $\langle K \rangle$, and the number of nodes N ?

✓ Question 7 [2 Marks]

Adjacency matrix of a directed graph can be written as:

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

①

②

④

③

Write the in-degree and out-degree sequence of this graph.

$\frac{5(4)}{2}$

4+3+2