(b) Define the following terms : (6)

(i) k-clan

(ii) Adoption

(iii) Betwenness Centrality

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 9940 **K**

Unique Paper Code : 2343010015

Name of the Paper : Social Network Analytics

Name of the Course : **B.Sc. (H) Computer Science**

Semester : VII

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.

Section A

1. (a) What is Social Network Analysis (SNA)? How has SNA been used to detect misinformation or influence campaigns on social media platforms. Explain in brief with the help of a suitable real-world example? (3)

(b) Consider the following adjacency list of an undirected network with 7 nodes (A, B, C, D, E, F, G) :

Node A -> [B, C, D]

Node B -> [A, C, E]

Node C -> [A, B, D, F]

Node D -> [A, C, F]

Node E -> [B, F, G]

Node F -> [C, D, E, G]

Node G -> [E, F]

Draw the graph corresponding to the given adjacency list and calculate the closeness centrality for the node E. (3)

(ii) Is {R1, R2, R3, R4, R5} a 2-clan? Justify your answer by computing the diameter of the induced subgraph. (6)

7. (a) Consider a small web graph (Figure 7) with 4 web pages (A, B, C, D) : (9)

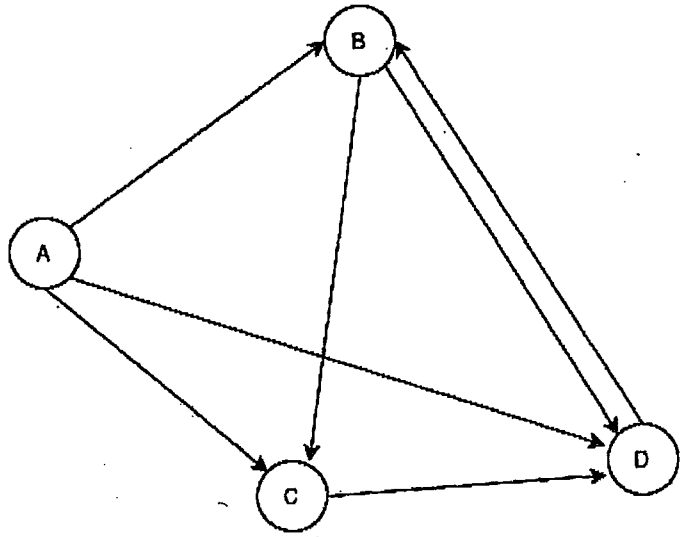

Figure 7

Assume Damping factor (d) = 0.85 and Initial PageRank for all pages = 0.25. Calculate the PageRank values of all nodes after two iterations of the algorithm.

with three different types of shapes and predictive communities are marked with three circles as shown below in Figure 6: (9)

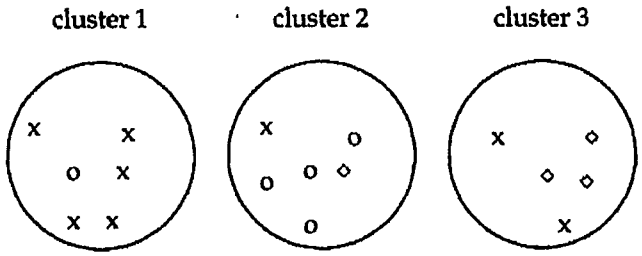

Figure 6

(b) In a collaboration network of 6 researchers {R1, R2, R3, R4, R5, R6}, the following pairs have co-authored papers: (R1, R2), (R1, R3), (R1, R4), (R2, R3), (R2, R5), (R3, R4), (R3, R5), (R4, R6), (R5, R6).

(i) Calculate the number of 3-cliques in this network.

(c) Generate a random graph using the Erdos-Renyi model with n=4 nodes and edge probability p=0.40. Assume the following random values generated for edge creation: (1, 2) = 0.45, (1, 3) = 0.55, (1, 4) = 0.35, (2, 3) = 0.48, (2, 4) = 0.45, (3, 4) = 0.20. Calculate the degree distribution of the generated graph. (3)

(d) Define assortativity. Differentiate between positive and negative assortativity coefficient? (3)

(e) Create the adjacency matrix for the network given below (Figure 1). (3)

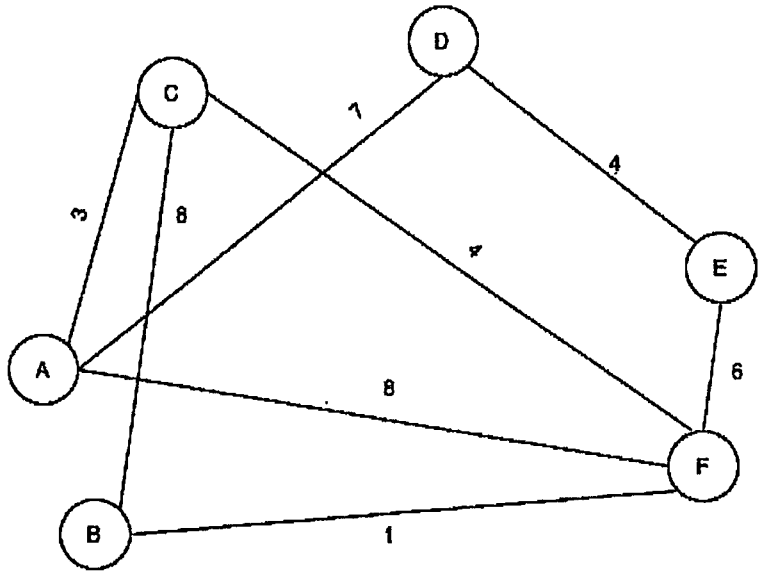

Figure 1

P.T.O.

(f) Consider a network with edges: (1, 2), (1, 3), (2, 3), (3, 4), (4, 5), (4, 6), (5, 6). A community detection algorithm identifies communities as C1={1,2,3} and C2={4,5,6}. Calculate the modularity Q for the communities C1 and C2. (3)

(g) Differentiate between Microscopic, Mesoscopic, and Macroscopic analysis of a network (3)

(h) In the PageRank algorithm what does the damping factor 'd' measure reflect? What happens when d = 0? (3)

(i) Consider a small network with 6 nodes (1, 2, 3, 4, 5, 6) as shown in Figure 2: (3)

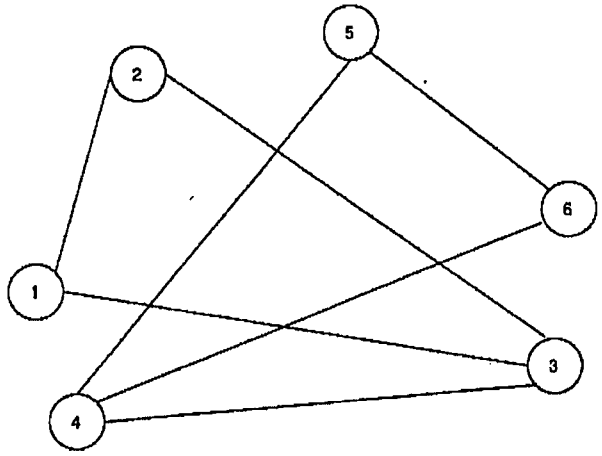

Figure 2

Find a trail, a path, and a walk in this network.

(i) Calculate the local clustering coefficient of nodes A, B, D, and E.

(ii) Find out the diameter of the network.

(iii) Find all the subgraphs forming 2-clubs of the network. (9)

(b) Consider a network G with node set V = {1, 2, 3, 4, 5, 6}. Let N(v) denote the set of neighbors of vertex v. Given that N(5)= {1, 2, 3, 4, 6} and N(6) = {2, 3, 4, 5}, compute the following measures between nodes 5 and 6: (6)

(i) Common neighbors

(ii) Jaccard similarity

(iii) Cosine similarity

6. (a) Compute purity and rand index by comparing the ground-truth and the detected community structures. Ground truth communities are marked

(b) Given the undirected graph in Figure 4 with 7 vertices, find the 2-core subgraph and a 3-plex subgraph. (6)

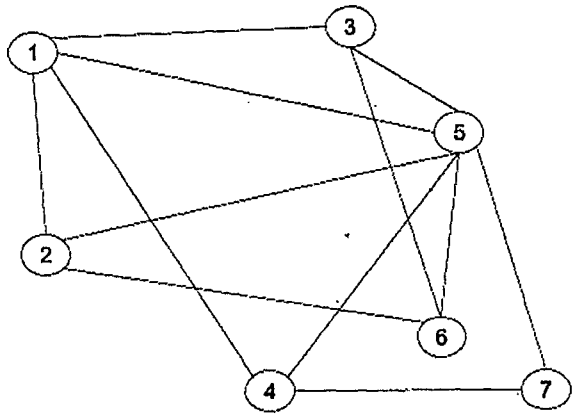

Figure 4

5. (a) Refer to the network illustrated in Figure 5:

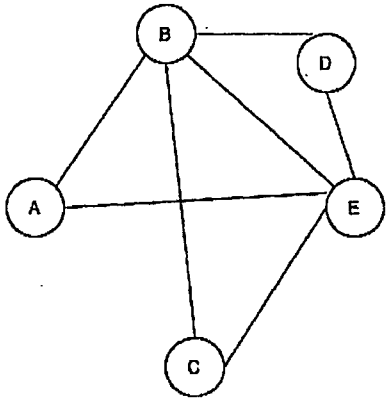

Figure 4

(j) A school is developing an epidemic model to understand seasonal flu transmission among its 100 students. The critical factor is that immunity after recovery is temporary, allowing students to be reinfected during the same flu season. Which epidemic modeling approach is most appropriate and why? (3)

Section B

2. (a) What are the three properties observed in Real World networks? Explain each of them in brief. (9)

(b) A measles outbreak occurs in a school with 120 students. Once recovered, students gain permanent immunity. (6)

Initial Conditions :

- Total population: N = 120
- Susceptible: S(0) = 110

- Infected: I(0) = 10
- Recovered: R(0) = 0

Model Parameters:

- Infection rate: $\beta = 0.6$
- Recovery rate: $\delta = 0.25$

(i) Calculate the rate of change of susceptible population

(ii) Calculate the rate of change of recovered nodes

(iii) Calculate the rate of change of infected population

3. (a) Consider the directed network given in Figure 3, and answer the following : (9)

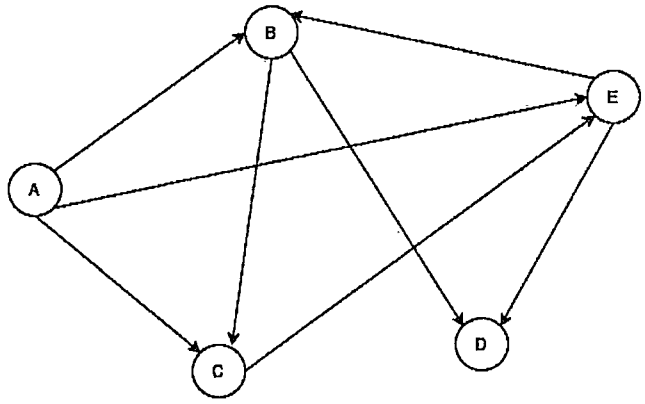

Figure 3

(i) Is this network strongly connected or weakly connected? Justify your answer.

(ii) Calculate Betweenness centrality for all nodes in the network.

(b) Explain the key differences between decision-based and probabilistic models in the context of information diffusion in social networks. (6)

4. (a) Explain the structure of a Ring Lattice Network. Compare its properties with real world networks. (9)