[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 270 **L**

Unique Paper Code : 2343010015

Name of the Paper : Social Network Analysis

Name of the Course : **B.Sc. (Hons.) Computer Science – DSE NEP-UGCF**

Semester : VI

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. This question paper has **two** sections **A** and **B**.
3. Question **1** in **Section A** is compulsory.
4. Attempt **any 4** questions from **Section B**.
5. Answer **all parts** of a question together.

Section A

1. (a) Draw the graph for the given adjacency list below of an undirected network with six nodes A, B, C, D, E and F. (3)

   Node A -> [B, D, E]

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

   Node C -> [A, B, E]

   Node D -> [B, C, F]

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

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

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

   (c) What is assortativity? Compare positive and negative assortativity coefficient. (3)

   (d) What does damping factor d reflect in PageRank algorithm? What happens when d=0? (3)

   (e) A college is developing an epidemic model to study transmission of a flu among its 120 students. The students can get reinfected during the same flu season since the immunity after recovery is not permanent. Which epidemic model is most suitable to describe the situation and why? (3)

   (f) Define community. List any two community detection methods. (3)

   (g) Create an adjacency matrix for the network (Figure 1) given below: (4)

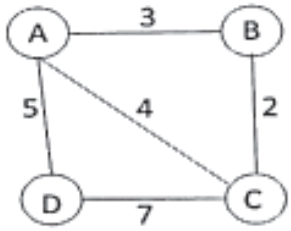

Figure 1

(h) Consider a network with edges: (A, B), (A, C), (B, C), (C, D), (D, E), (D, F), (E, F). A community detection method identifies communities as C1 = {A, B, C} and C2 = {D, E, F}. Compute modularity for the communities C1 and C2. (4)

(i) Define the following terms: (4)

(i) hub

(ii) contagion

(iii) K-plex

(iv) Degree centrality

Section B

2. (a) Explain the three fundamental properties observed in Real World Networks. Also compare real world network with random network. (6)

(b) A viral infection spreads in a hostel containing 150 students. Once recovered, students gain temporary immunity and may become susceptible again. Consider the initial conditions and parameters as follows and calculate the following: (3x3=9)

Initial Conditions:

Total Population: $N = 150$

Susceptible: $S(0) = 130$

Infected: $I(0) = 20$

Recovered: $R(0) = 0$

Parameters:

Infection Rate (β) = 0.25

Recovery Rate (γ) = 0.10

(i) Calculate rate of change of susceptible population.

(ii) Calculate rate of change of infected population.

(iii) Calculate rate of change of recovered population

3. For the network given below (Figure 2), compute the following measures: (5x3=15)

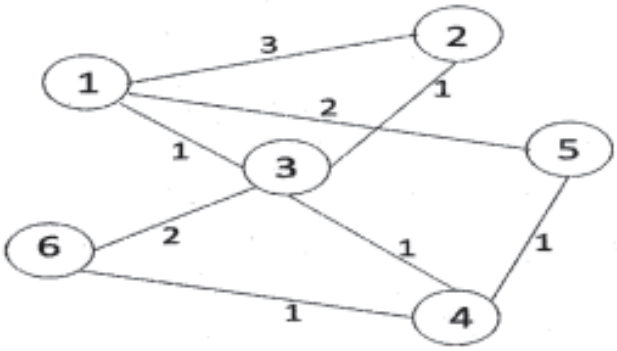

Figure 2

(i) degree distribution of the network

(ii) diameter of the network

(iii) local clustering coefficient of node 2

(iv) density of the network

(v) closeness centrality of node 3

4. (a) Explain different epidemic models. (6)

(b) Calculate purity and rand index of the community distribution as given in Figure 3. Ground truth communities are marked with three different types of shapes and communities predicted are marked with three circles as shown below in the figure. (9)

Figure 3

5. (a) Consider a network with a set of nodes V= {1, 2, 3, 4, 5, 6}. Let N(v) denote set of neighbours of vertex v. Given that N(2) = {1, 2, 3, 4, 6} and N(3) = {2, 3, 4, 5}. Calculate following similarity measures between the nodes 2 and 3. (6)

(i) Jaccard similarity

(ii) Common neighbours

(iii) Cosine similarity

(b) Consider a web network given in Figure 4 with web pages A, B, C and D. Compute pagerank for all web pages for two iterations of the algorithm. Assume damping factor d=0.85. (9)

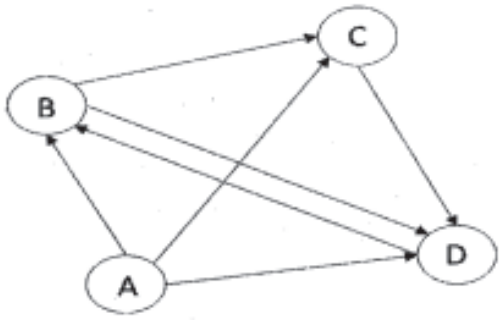

Figure 4

6. (a) Define K-clique. What is the significance of 'K' in this method? Compare K-clique, K-clan and K-club using an example. (9)

(b) Write short note on the following: (4x1.5=6)

(i) Strongly connected and weakly connected graph

(ii) Betweenness centrality

(iii) average path length

(iv) Preferential attachment model

7. For the directed network given below (Figure 5), answer the following questions:

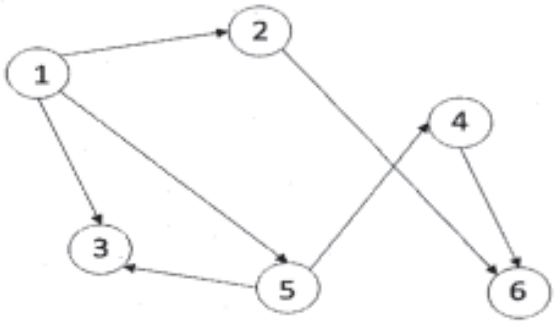

Figure 5

(i) Find if the network given is strongly connected or weakly connected graph. Justify your answer (7)

(ii) Calculate betweenness centrality for all nodes. (8)