This question paper contains **7** printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : **8073**

Unique Paper Code : **2343010015**

Name of the Paper : **Social Network Analysis**

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

Semester : **VI**

Duration : **3 Hours** Maximum Marks : **90**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Section A is compulsory. Attempt any *four* questions from Section B.

Answer *all* parts of a question together.

SECTION A

1. (*a*) Differentiate between a trail, path and cycle in a network using an example. 3

(*b*) The adjacency matrix of a network is symmetric, all entries are either 1 or 0, and all diagonal entries in this matrix are zeros. Identify *three* properties of this network. 3

P.T.O.

(*c*) Consider the undirected network G = (V, E), with the following sets of vertices and edges :

V = {1, 2, 3, 4, 5, 6, 7}

E = {(1, 2), (1, 3), (1, 4), (1, 5), (3, 5), (3, 6), (4, 6), (4, 7), (6,7)}

What is the density of network G ? What is the maximum possible density of any network ? Justify your answer. 3

(*d*) Find the degree distribution of network G given in question 1(*c*) and plot it. 3

(*e*) List *three* distinct properties of real world networks. 3

(*f*) What is a ring lattice network ? Show an example of a ring lattice network where each vertex has degree (k) = 4. 3

(*g*) Give *three* applications of community detection in social networks. 3

(*h*) What is a clique in a graph ? Can cliques in networks be considered as communities ? Why or why not ? 3

(*i*) Define the parameters birth rate and death rate for the SIR model. 3

(*j*) What is the basic idea behind the Page Rank algorithm ? What is the role of the damping factor in the Page Rank algorithm ? 3

SECTION B

(Attempt any *four*)

2. Consider the following Adjacency Matrix (M) :

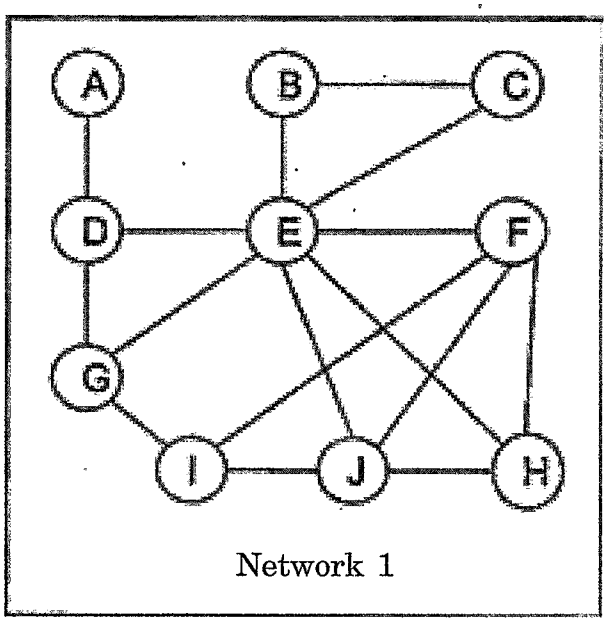
	A	B	C	D	E
A	0	6	0	0	4
B	0	0	0	0	0
C	0	3	0	0	0
D	0	2	5	0	0
E	0	2	0	1	0

(*a*) Identify a hub node and an authority node in the graph corresponding to adjacency matrix M. Justify your answers. Can a node be both a hub node and an authority node ? Why or why not ? 5

(*b*) Draw the graph corresponding to the adjacency matrix M. 4

(*c*) Give the adjacency list representation for the adjacency matrix M. List *two* advantages and disadvantages each of an adjacency matrix representation over an adjacency list representation. 6

3. Consider the following Network (Network 1) :



Network 1

(*a*) List the distance between every pair of nodes in Network 1. 5

(*b*) Define the diameter and average path length of a network. Find the diameter and average path length of Network 1. 4

(*c*) Find the degree centrality, closeness centrality and betweenness centrality of vertex E of Network 1. 6

4. (*a*) Prove that a giant component emerges in a random network when the average degree of the network is greater than or equal to 1. 5

(*b*) Which properties of real world networks are different from those of random networks ? 4

(*c*) Describe the process of a Watts-Strogatz network formation. 6

5. (*a*) Define the Purity and Rand Index metric that are used to evaluate disjoint communities. Compute the Purity and Rand Index of the community distribution shown in Fig. 1 : 5

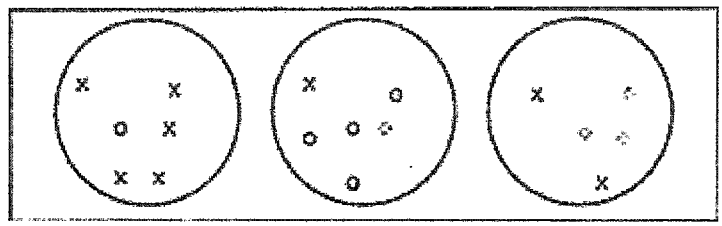


Figure 1

(*b*) Briefly describe the types of communities observed in social networks. 4

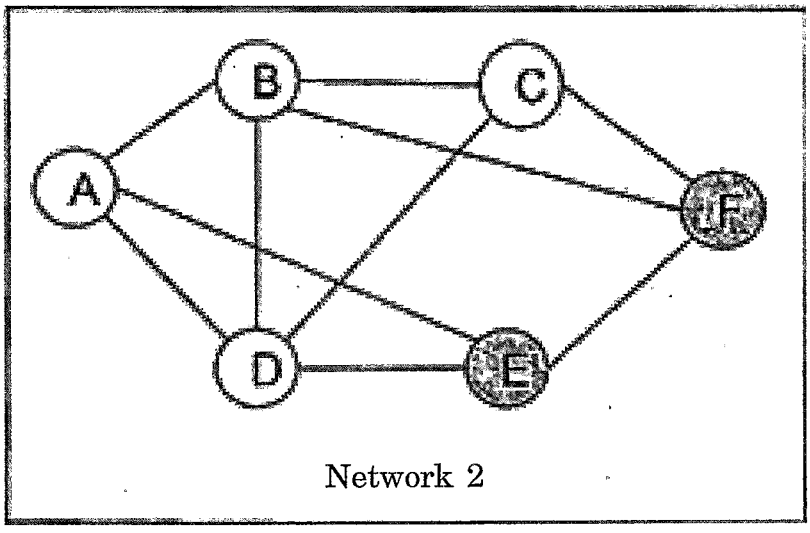
(*c*) Give the steps for the Louvain method for community detection. 6

6. (*a*) What is the epidemic threshold and why do we need it for the SIS epidemic model ? When does the epidemic die out ? 5

(*b*) Assume that there are two strategies A and B that can be adopted by individuals. B gives a payoff of 5; using both costs 5. What should be the minimum payoff for A, so that everyone goes with strategy A ? 4

(*c*) Briefly explain the two types of models that describe cascade behaviour on networks. 6

7. Consider the following Network (Network 2).



Network 2

(*a*) A community detection algorithm performed on Network 2 shown above, discovers two communities with the assignments C_1 = {A, B, C, D} and C_2 = {E. F}. Compute the modularity of this community assignment. 5

(*b*) Explain the transitivity metric in a social network. In Network 2 shown above, identify the nodes that exhibit transitive behaviour. 4

(*c*) Find the structural equivalence between vertices A and B of Network 2 using the measures—Common Neighbors, Jaccard similarity and Cosine similarity. 6