M.TECH/CSE/3RD SEM/CSEN 6159/2018
SOCIAL NETWORK ANALYSIS
(CSEN 6159)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i)   Results from the experiments designed by Milgram support the theory of
         (a) diffusion of information   (b) six degrees of separation
         (c) preferential attachment   (d) none of these.

   (ii) The normalization factor for calculation of betweenness of a node is given by,
         (a) n(n-1)   (b) n(n-1)/2   (c) (n-1)(n-2)/2   (d)n^2

   (iii) Which is not TRUE about an Erdos-Renyi network?
         (a) It may follow a G*(n, m)* model   (b) It may follow a G*(n, p)* model
         (c) Degree distribution is binomial   (d) It is a scale-free network.

   (iv) Features of an SIS model can be observed in
         (a) common cold   (b) swine flu
         (c) bird flu   (d) malaria.

   (v)   Closeness value should lie within the range,
         (a) 0 to 1 (both inclusive)   (b) -1 to 0 (both inclusive)
         (c) -0.5 to 0.5 (both inclusive)   (d) -1 to 1 (both inclusive).

   (vi) Which of the following is an overlapping community detection algorithm?
         (a) Louvain   (b) Girvan-Newman
         (c) Clique percolation   (d) Clauset-Newman-Moore (CNM).

   (vii) Propagation probability is a model parameter in the following model
         (a) SIS model   (b) SIRS model
         (c) Independent cascade model   (d) Linear threshold model.

   (viii) Diameter of a network is the
         (a) shortest of all shortest paths   (b) longest of all longest paths
         (c) longest of all shortest paths   (d) shortest of all longest paths.

   (ix) Betweenness can be calculated in
         (a) O(n)   (b) $O(n^2)$ (c) O(nlogn)   (d) $O(n^3)$.

   (x)   Hub and authority values can be calculated by,
         (a) HITS   (b) PageRank
         (c) Bonacich's power centrality   (d) betweenness

Group – B

2. (a) Define Bonacich's power centrality and explain how its mathematical representation can accommodate two contradictory ideas of how powerful a node is. Describe the mathematical equation to find power using Bonacich's power centrality.

   (b) What is degree centrality? "Degree distribution in a social network usually follows power-law distribution" – what is the significance of this statement?

                                        (2+ 2 +3)+(2 + 3) = 12

3. (a) What is PageRank? What is 1) dead-end and 2) spider trap, related to PageRank. How can they be avoided?

   (b) Explain the concepts of 1) betweenness, 2) local clustering co-efficient, with one example each.
                                        (2 + 2 × 2.5) + (3 + 2)=12

Group – C

4. (a) Explain the concept of "preferential attachment".

   (b) Prove that preferential attachment leads to generation of a scale-free network.
                                        2 + 10 = 12

5. (a)   Describe the important features of Barabasi-Albert network model.
   (b) Describe small-world network model as described by Watts-Strogatz.
                                        6 + 6= 12

Group – D

6. (a) What is the reproductive number in epidemiology? How can we categorize the nature of an epidemic in terms of reproductive number?

   (b) Find out speed of an epidemic using Fisher's equation in an SI model. Start by writing the differential equations for SI model using *t* and *x*.
                                        4 + (5 +2 + 1) = 12

7. (a) Write the pseudo-code/ C program to implement the independent cascade model. Assume that the graph information is already available in an adjacency list.

   (b) Describe the SIR model and find out the relationship between *S(t)* and *I(t)*.
                                        6 + 6 = 12

Group – E

8. (a) What is conductance? How is it related to detection of communities in social networks?

    (b) Describe Louvain method for detecting communities in social networks. State all the stages and describe them separately. Clearly mention the equation which helps calculating change in modularity. Comment on the time complexity of the method.

    4 + (5 + 2 + 1) = 12

9. (a) Explain Girvan-Newman (GN) algorithm for detection of community structures in social networks. Comment on the time complexity of the algorithm. What are the limitations of GN algorithm?

    (b) Explain modularity in networks.

    8 + 4= 12