

**Master of Computer Applications**  
**MCAE303: Network Science**  
**Unique Paper Code: 223422304**  
**Semester III**  
**December 2024**  
**Year of Admission: 2023**

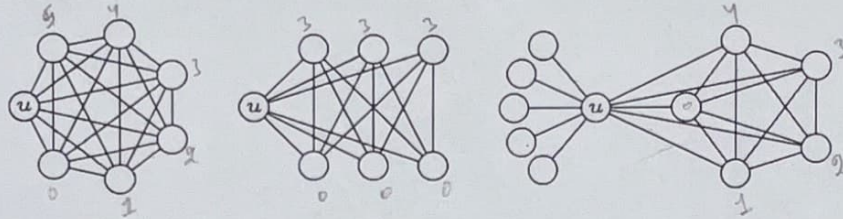
**Time: 3 hours**

**Maximum Marks: 70**

**Note:** Parts of a question should be answered together. Attempt all questions.

1. Define clustering coefficient and its applications.

[14]



Calculate clustering coefficient of the above graphs about the node 'u'.

Discuss the degree distribution of a network. Calculate degree distribution for the above graphs. Sketch the degree distribution of the above graphs.

What is random network and how do you create it? Deduce  $p = \frac{\langle k \rangle}{N}$ , where  $N$  is number of nodes in the random network and  $\langle k \rangle$  is average degree of the network.

Construct your deduction for the probability of degree of nodes from binomial distribution to  $p(k) = e^{-\langle k \rangle} \frac{\langle k \rangle^k}{k!}$ .

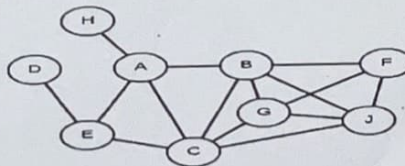
2. What is scale free network? Where and when it is exhibited. Deduce the degree of scale-free network under continuum formalism  $p(k) = Ck^{-\gamma}$ , where  $C = (\gamma - 1)k_{\min}^{\gamma-1}$ , here  $k_{\min}$  is minimum cut-off degree. Derive the first, second and  $k^{\text{th}}$  moments of  $p(k)$

[14]

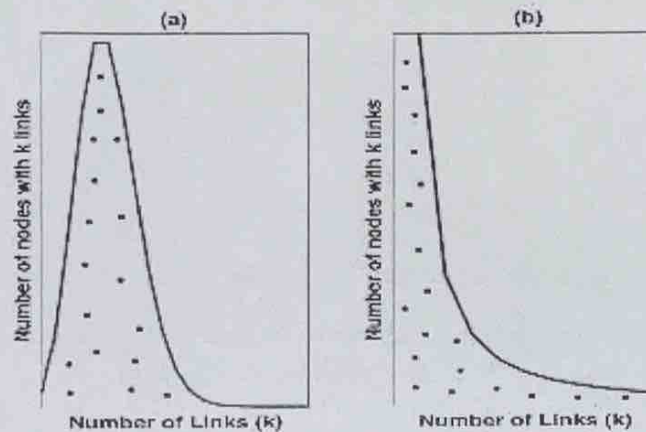
3. Discuss the concept of growth and preferential attachment in real networks. Derive the Barabási-Albert model for the network's degree distribution for using rate equation, growth, and preferential attachment procedures.

Derive the formulation  $\langle d \rangle = \frac{\log N}{\log \langle k \rangle}$  for average distance between two nodes in the networks. Calculate  $\langle d \rangle$  for the following figure:

[14]



4. State the difference between random, scale-free, and power law networks with examples. What is Bianconi-Barabási model? Deduce the fitness model and derive the network's degree distribution using uniform fitness distribution. How is the deduction different from the Barabási-Albert model? Establish the distinction between the following graphs: [14]



5. What is community detection? Give applications of community detection procedure. Construct similarity matrix using Ravasz algorithm based on Single linkage and complete linkage methods. Illustrate dendrogram representations for both. [14]

