Q1. If the adjacency matrix of a weighted graph is symmetric, what does this indicate?

    A. All edges have equal weight.

    B. The graph is directed.

    C. The graph is undirected.

    D. All nodes have the same weight.

Key: C

Q2. What is the average degree of a directed graph with 12 nodes and 25 edges?

    A. 4.2

    B. 3.5

    C. 5.4

    D. 2.1

Key: A

Q3. What defines a graph to be bipartite?

    A. The graph has no cycles.

    B. The graph has a single component.

    C. The graph has two complements.

    D. The nodes can be divided into two disjoint sets with no edges within the sets.

Key: D

Q4. For a Random Network with $N = 10^4$ nodes and a linking probability of $p = 0.5 \cdot 10^{-3}$, what is the most convenient degree distribution we should?

    A. $p_k = \binom{N-1}{k} \cdot p^k \cdot (1-p)^N$

    B. $p_k = \dfrac{N(N-1)}{2}$

    C. $p_k = e^{-\langle k \rangle} \dfrac{\langle k \rangle^k}{k!}$

    D. $p_k = p\dfrac{N(N-1)}{2}$

Key: C

Q5. What are the properties that are dependent on a single parameter $\langle k \rangle$ in the Poisson degree distribution networks?

A. Peak position and network size.

B. Network size and dispersion of the distribution.

C. Peak position and dispersion of the distribution.

D. The number of expected links of the network.

Key: C

Q6. What are some of the conclusions drawn from Milgram's Experiment?

A. There's a lack of short paths in Social Networks.

B. There is no small world phenomenon in social connections.

C. People effectively find short paths in networks without a global map.

D. Social networks are too vast for effective communication.

Key: C

Q7. What is the relevance of the random network model in network science?

A. It's the perfect model for real-world networks.

B. It holds no relevance in the study of real networks.

C. It serves as an important reference for understanding real networks.

D. It's the only model applicable to large networks.

Key: C

Q8. How does the average path length between nodes behave in scale-free networks, as γ approaches 2?

A. It stays constant regardless of γ.

B. It exponentially increases.

C. It linearly increases with the number of nodes N.

D. It linearly decreases with the number of nodes N.

Key: A

Q9. What distinguishes a scale-free network from a random network in terms of its degree distribution?

A. Scale-free networks have a uniform degree distribution across nodes.

B. Random networks have a power-law degree distribution.

C. Scale-free networks have many low-degree nodes and a few high-degree hubs.

D. Random networks have a Gaussian degree distribution.

Key: C

Q10. What is Preferential Attachment in the Barabási-Albert model?

A. New nodes attach randomly to any node in the network, supporting the BA model.

B. Preferential Attachment implies new nodes are more likely to connect to low-degree nodes.

C. It suggests new nodes prefer to attach to high-degree nodes.

D. The probability of link formation in the BA model is independent of node degrees.

Key: C

Q11. How is Betweenness Centrality computed in a graph?

A. It measures the ratio of connections within a community.

B. It sums the paths that cross a node over all possible shortest paths.

C. It counts the number of nodes a certain node is directly connected to.

D. It measures the number of triangles a node forms with other nodes.

Key: B

Q12. What does the Maximal Modularity Hypothesis suggest about community structure in a network?

A. The network should have as many communities as possible.

B. A partition with maximum modularity represents the optimal community structure.

C. Networks should avoid any community structure.

D. The community structure of a network does not impact its functionality.

Key: B

Q13. How does the Girvan-Newman Algorithm work?

A. It adds random links to form communities.

B. It looks for disconnected nodes.

C. It systematically removes links connecting nodes from different communities.

D. It removes nodes belonging to small communities.

Key: C

Q14. How is *homophily* defined in the context of social networks?

A. The tendency for people to form connections with those who are similar to them.

B. The formation of connections due to geographic proximity.

C. The presence of shared friends within a network.

D. The tendency for social networks to evolve over time.

Key: A

Q15. What is *triadic closure* in the context of social network theory?

A. The tendency for individuals to gather in small groups.

B. The formation of closed loops between connected nodes.

C. The closing of connections between multiple social circles in a network.

D. The process by which two individuals who share a connection are likely to form a connection themselves.

Key: D

Q16. Explain the concept of structural balance in the context of positive and negative relationships within a social network.

A. All relationships are positive in a complete graph.

B. Unbalanced triangles are desirable.

C. Balanced triangles are undesirable.

D. Every set of three nodes is balanced.

Key: D

Q17. In the context of the bipartite matching problem, the perfect matching can only be given if:

A. Each node is connected to all nodes on the other side.

B. No two nodes on one side are connected to the same node on the other side.

C. All nodes on the left have the same preferences.

D. Nodes on one side have equal valuations.

Key: B

Q18. Define constricted sets in the context of the bipartite matching problem.

A. Sets of nodes with equal valuations.

B. Sets of nodes that prefer each other.

C. Sets of nodes with the same degree.

D. Sets of nodes with total preferences less than the number of nodes.

Key: D

Q19. In the Susceptible-Infected-Susceptible (SIS), what factors influence the transition from the endemic state and the disease-free state?

A. The transition depends on the initial number of infected individuals only.

B. The transition is solely influenced by the recovery rate.

C. The transition depends on both the recovery rate and the transmission rate, with a critical threshold determining the state.

D. The transition is unrelated to the recovery rate or transmission rate.

Key: C

Q20. Given the following function in the SIS model of an epidemic that affects 4 million people:

$$i(t) = \frac{0.125e^{0.3t}}{1 + 0.5e^{0.3t}}$$

where t represents time in years. Which statement is true?

A. The stationary state is reached when 1 million people are infected.

B. The epidemic is in the Disease-free State.

C. The entire population is expected to be infected at some point in time.

D. The stationary state is attained when $i = 0.125$.

Key: A