

Indian Institute of Engineering Science and Technology, Shibpur
Dual Degree (B.Tech. - M.Tech.) 5th Semester (CST) Examination (End Semester)
November, 2023
Graph Algorithms (CS 3104)

Full Marks: 50

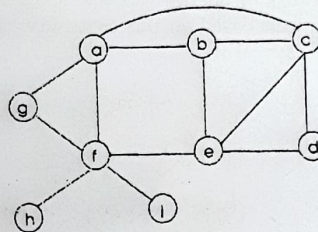
Time: 3 Hours

*Answer Question-1 and any four from the remaining.
Do all parts of a question together. Do not mix up answers to parts of different questions in the answer script.*

1. (a) State Max flow min cut theorem and prove it through an example.
- (b) An undirected graph G has 8 edges. Find the number of vertices, if the degree of each vertex in G is 2.
- (c) State and prove the handshaking theorem.

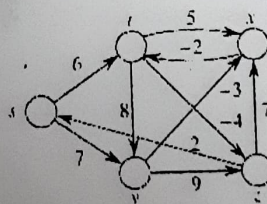
[4 + 3 + 3 = 10]

2. (a) Define vertex colouring of a graph G and show that every planar graph is 5-vertex colourable.
- (b) Construct a possible spanning tree of the graph depicted in following Figure using the Kruskal's algorithm. Show the result of each iteration of the algorithm.



[4 + 6 = 10]

3. (a) what is an undirected graph ? Prove that an undirected graph has even number vertices of odd degree.
- (b) Run the Bellman-Ford algorithm (for finding Single-source shortest-path) for the following directed graph using the vertex, z as source. In each pass relax the light edges and show the d and π values after each passes.

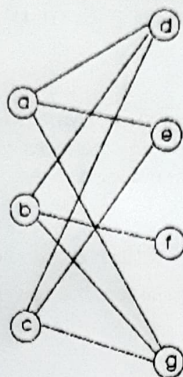


[4 + 6 = 10]

4. (a) Using Kuratowski's theorem, show that the Petersen's graphs are non-planar.
- (b) Prove, that every planar graph, which has no loops or multiple edges, and v vertices ($v \geq 3$) and e edges then $e \leq 3v - 6$.

[6 + 4 = 10]

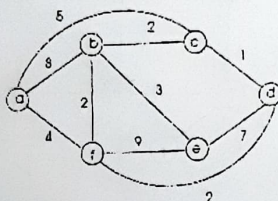
- ✓ 5. (a) Using the augmenting path algorithm, find out the maximum matching in the bipartite graph below. Show the result of each iteration of the algorithm.



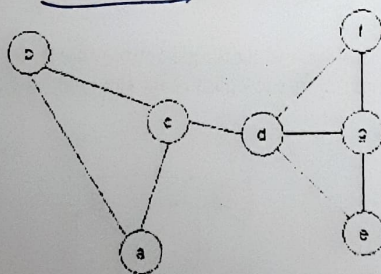
- (b) Prove that the chromatic number of a graph will not exceed by more than one the maximum degree of the vertices in a graph.

$$[6 + 4 = 10]$$

- ✓ 6. (a) Compute vertex betweenness centrality of all the vertices of the following graph. According to you, which vertex is the most important based on this centrality value, and why?



- (b) Find the clustering coefficient for each vertex in the graph below and work out the average clustering coefficient. Also, find the matching Index of the two nodes c and d.



$$[(4 + 1) + (4 + 1) = 10]$$