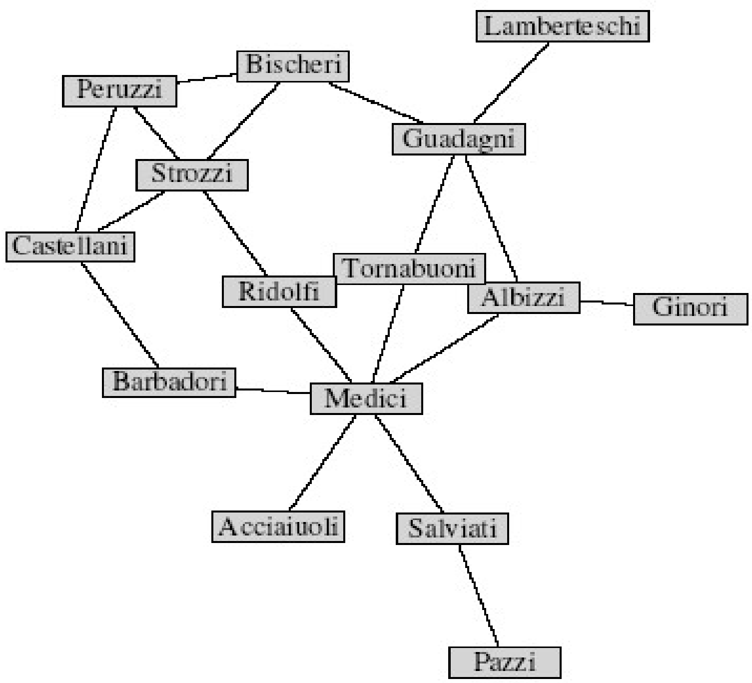
INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date 17.02.2005 **FN Time:** 2 Hrs. **Full Marks :** 30 **No. of Students:** 20
Spring Semester: 2006 **Department:** Computer Science and Engineering
Sub. No: CS 60078 **Sub. Name:** Complex Network Theory

Question 1

Given below is a famous network from the field of social networks



In this network vertices are influential families of 15th century Florence and the edges represent intermarriage between families (Padgett and Ansell 1993).

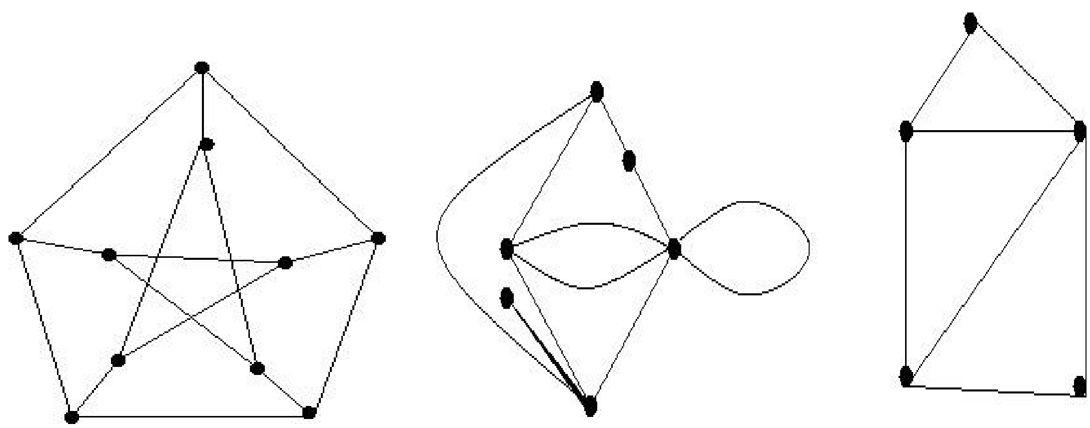
Inspect the network and answer the following questions:

a) Which vertex has the highest degree centrality? Which vertex has the second highest?
b) Find out the clustering coefficient of the node "Guadagni". Is there any significance of clustering coefficient for this network?
c) Identify a vertex which can be called a structural hole. Justify your answer in this context. Give an algorithm to find the structural hole.

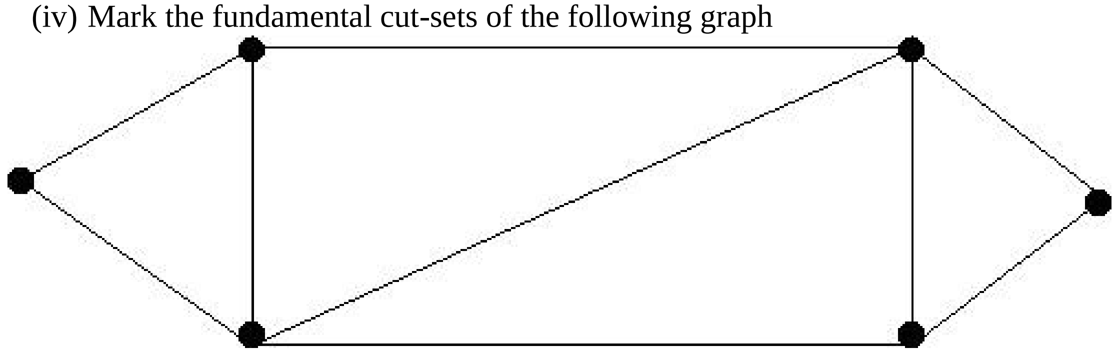
d) Consider the set S = {Peruzzi, Bischeri, Castellani, Ridolfi}. Is S a 2-clique? Justify.
e) Identify the 2-clan/s in the network. Is there any 2-club in the network?
f) State one interesting observation that you can make about this network.

1+1.5+2+1+1.5+1= 8

Question 2: Planar Graphs.



(i) Draw figures showing that the graph is not planar, using Kuratowski's theorem. (Hint: Kuratowski's theorem says a graph must contain an expansion of K5)
(ii) Construct the geometric dual
(iii) State Planarity detection algorithm and show how it functions for the above mentioned diagram
(iv) Mark the fundamental cut-sets of the following graph



3+2+1.5+1.5= 8

Question 3

Define :

- Separable Graph
- Unicursal line
- K-plexes
- strong structural coloring
- Pendant vertices
- cut-set
- incidence matrix
- Edge-disjoint subgraph
- isomorphic graph
- Bipartite graph

10 x 0.5 = 5

Q4.

1. Define relationship between diameter of a graph and its adjancency matrix
2. State max-cut min-flow theorem and provide an informal proof.
3. State why the diameter of the k-plex is <= 2, where k < (n+2)/2
4. Proof that a connected planar graph with n vertices and e edges has e-n+2 regions.

1 + 2.5 + 1 + 2.5 = 7