

Step-1

A spanning tree of a connected graph of n vertices is a connected subset of the graph, which has all the n vertices but only $n-1$ edges. A graph may have various spanning trees. Since the graph has 7 vertices, its spanning tree must have 6 edges.

Thus, it is clear that we have to remove 6 edges from the graph to obtain a spanning tree.

Therefore, the incidence matrix has 6 linearly independent rows.

Thus, the rank of the incidence matrix must be 6.

Step-2

Consider the system $Ax = b$.

Here the matrix A is of the order 12 by 7, the matrix x is of order 7 by 1, and therefore, the matrix b is also of the order 12 by 1.

This system has 12 equations in 7 unknowns.

Thus, there is exactly one free variable in the solution to the system $Ax = b$.

Step-3

Consider the system $A^T y = f$.

Here the matrix A^T is of the order 7 by 12, the matrix y is of the order 12 by 1, and therefore, f is a matrix of the order 7 by 1.

This system has 7 equations in 12 unknowns.

Thus, there are 6 free variables in this system.