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TIME TABLE SCHEDULING IN BIPARTITE GRAPH GRAPH USING LATEX

Mrs Renuga Devi S*,Amy Gladys Veronica S**

Assistant professor*,Student**

Department of Mathematics

Hindusthan college of arts and science,

Coimbatore,Tamil Nadu

ABSTRACT : Presenting some graph theoretical planning techniques which have been employed in the design of a GSM (Group Special Mobile) operated by the Bharat Sanchar Nigam Limited. Apart from a new variant of the by now classical application of graph colouring to frequency assignment, these techniques deal with the determination of the base station identity code (BSIC), hopping sequence number (HSN), and location area code (LAC). It is shown that GSM radio network planning involves a number of optimization problems and Time Table Scheduling Problems which can be treated by graph theoretical methods.

Key Words: Bipartite Graph, Euler graph, Hamiltonian graph, Connected graph, planner graph (Ref: IJCA,Issue:Feb2021, pg:21)

1.1 Introduction:

Introduced in 1878 by Sylvester, who compared "Quantic invariants" with the covariants of algebra and molecular diagrams. When working on colorations in 1941, Ramsey discovered a new subfield of graph theory known as very graph theory. Heinrich used computer technology to provide a solution to the four-color puzzle in 1969. Random graph theory was developed through the investigation of asymptotic graph connectedness.

The Kinser Bridge Problem was the catalyst for the development of graph theory in 1735.

The Eulerian Graph notion was born because of this issue. In order to solve the Konigsberg bridge puzzle, Euler researched the issue and created what is now known as an Eulerian graph. In 1840, A.F

Krakowski demonstrated that they are planar by using the concepts of complete graphs and bipartite graphs that Mobius provided.

1.2 Definitions:

A graph is made up of a set of vertices V connected by a set of edges E, and is typically expressed by the symbols G (V, E) or G = (V, E). In a graph, the number of vertices is typically expressed by n, while the number of edges is typically denoted by m.

Vertices: Vertices correspond to nodes, points, and actors (in social networks).players or agents.

Edges: In social networks, connections or links and edges are terms that are used interchangeably.

The unordered pair of vertices that act as the edge's end points, e = (u, v), define the edge.

Example: The graph in Figure 1 has an edge set and a vertex set of a, b, c, d, e, and f.

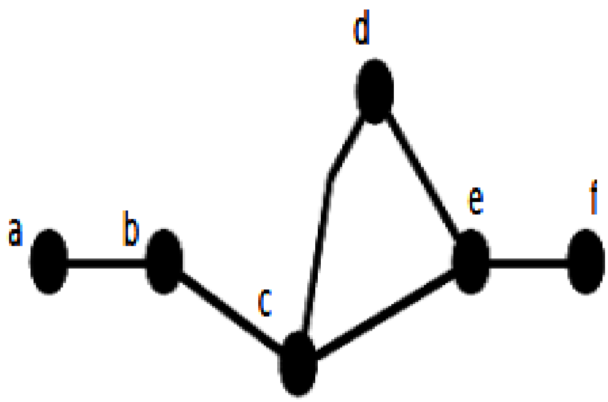


Figure 1.

E is defined as (a, b), (b, c), (c, d), (c, e), (d,e),(e,f)

Definition:vertices If there is an edge (u, v) that connects u and v, they are said to be neighbouring.
When an edge (u, v) touches nodes u and v, it is considered to be incident.
Self-loop:A self-loop or reflexive tie is an edge with the equation e = (u, u) that connects one vertex to another.
Matrix of Adjacency: Every graph has an adjacency matrix, which is a binary n n matrix, attached to it.
If vertex vi and vertex vj are next to each other in matrix A, then aij = 1, aji = 1, and aij = 0 and

If not, aji equals 0. An adjacency matrix is best represented graphically by a table, like the one below.

	a	b	c	d	e	f
a	0	1	0	0	0	0
b	1	0	1	0	0	0
c	0	1	0	1	1	0
d	0	0	1	0	1	0
e	0	0	1	1	0	1
f	0	0	0	0	1	0

Adjacency matrix for graph in Figure 1.
One can see that not every vertex is directly adjacent to every other by looking at either Figure 1 or the provided adjacency Matrix. A complete graph is one in which every vertex is next to every other vertex.

A graph's corresponding subgraph G is a graph in which all of its points and lines are contained. An entire portion of G is referred to as a full subgraph of G.
Despite the fact that not all of the vertices in the network shown in Figure 1 are adjacent, it is possible to create a set of adjacent vertices by connecting any two vertices. Graphs with this feature are referred to as linked.
Reachability. Similar to this, a pair of vertices is said to be accessible if one vertex can affect the other by way of a series of nearby vertices. The reachability matrix R shown in Figure 2 can be created by determining reachability for each pair of vertices.
The result of applying transitive closure to the adjacency is the matrix R.
matrix A.

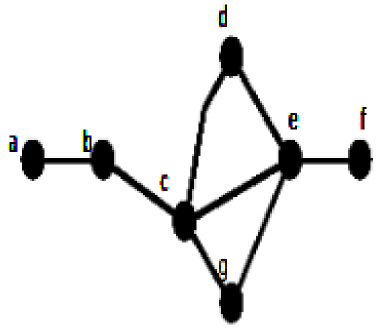


Figure: 2

A path connecting every node in a maximum subgraph of a graph, which is a well-defined definition of a component (i.e., they are mutually reachable). The quantity of nodes that a component has is what is meant by the term "size." An isolated component makes up a connected graph.

Walk:A walk is a collection of the adjacent vertices v0, v1, and vn. The order a, b, c, b, c, and g in Figure 3 represents a stroll. An alternative way to think about a walk is as a series of incident edges, where two edges are considered incident if they segment or share the same identical vertex. If vo = vn, the stroll is finished.

Path:A route is a path where no vertex appears more than once. The order a, b, c, d, e, and f in Figure 3 represents a path.

Trail:A trail is a path where no edge appears more than once. In
Figure 3 shows a trail rather than a path in the order a, b, c, e, d, and g.
Every trail is a stroll, and every path is both.

Cycle:A closed path where n >= 3 is referred to as a cycle. The order c, e, and d
A cycle is shown in Figure 3.

Tree: A linked graph with no cycles is referred to as a tree. Every pair of points in a tree is connected by a different path. That is, there is just one possible route from point A to point B.

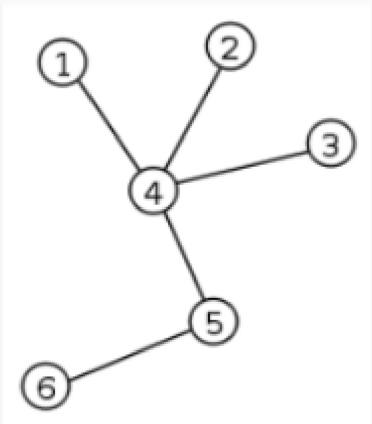


Figure 3: A labeled tree with 6 vertices and 5 edges

A spanning tree is a subgraph of a graph, or a tree, that contains every vertex in the graph G.
A walk's length is determined by the number of edges it has, which also applies to a road or trail. For instance, the path amebicide in Figure 3 has a length of 4.

Degree of vertex: The degree of the vertex is the quantity of vertices that surround a specific vertex, and it is represented by the symbol d. (v).

Bigraph:A bipartite graph (also known as a bigraph) is a graph whose vertices may be split into two distinct sets U and V such that every edge is preserved.
A graph that has no odd-length cycles is said to be bipartite.The two sets U and V can be compared to colouring the graph with two different colours. For example, if one colours all of the nodes in U blue and all of the nodes in V green, each edge will have endpoints that are different colours, as required by the graph colouring problem. [3] [4] However, in the case of a non-bipartite graph, such as a triangle, where one node is coloured blue and another green, such colouring is impossible because the triangle's third vertex is connected to the vertices of both colours, making it impossible to assign it any colour.
A bipartite graph is defined by two sets of disconnected vertices, U and V, and a set of connected edges, E. Every vertex in a perfect matching has precisely one edge incident on it. A perfect matching is a subset of the edge set E. We will assume that |U| = |V |= n since perfect matches in the graph G are what we are interested in. Let U be [u1] [u2] [____] [un] and V be [v1] [v2] [____] [vn]. If G does not have a perfect matching (no instance), the method makes no errors, and if G does have a perfect matching, errors are made with a probability of no more than one-half (yes instance).

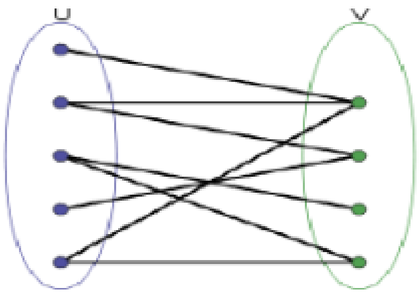


Figure 4: Example of a bipartite graph.

TYPES OF BIGRAPH:

- Acyclic Graphs
- Book Graphs
- Crossed Prism Graphs
- Gear Graphs
- Hypercube Graphs
- Knight Graphs
- Ladder Graphs
- Path Graphs
- Mongolian Tent Graphs
- Ladder Rung Graphs
- Hadamard Graphs
- Haar Graphs
- Gear Graphs
- Grid Graphs
- Stacked Book Graphs

GRAPH THEORY APPLICATIONS: Real-world applications of graph theory include the internet, social media, web page searching, city planning, traffic control, transportation, and navigation, the travelling salesman problem, GSM mobile phone networks, map colouring, schedule scheduling, and more.

LISTING OF GRAPHS:A graph's order is determined by its vertex count, or |v|.
A graph's |E| number of edges measures its size.

OVERALL SUBGRAPH:A subgraph that has every vertex of the initial path is said to be spanning.

2.1 EULERIAN CIRCUIT: In a graph G, an Eulerian circuit is a circuit that contains each vertex and each edge. Although a vertex may be passed through more than once, a circuit requires that each edge be traversed exactly once. A Eulerian graph is one that contains an Eulerian circuit. A travel through every vertex and precisely once along every edge of a graph G is referred to as an Eulerian path, right?

Example: Seven bridges crossed the Pregel River in the city of Königsberg (now Kaliningrad). People pondered if it would be possible to stroll through the city while crossing each bridge exactly once. Euler constructed the model graph, noted that it contained vertices of odd degree, and demonstrated that this rendered such a walk impractical.

CIRCUIT OF HAMILTON: The discovery of a Hamilton path in the graph is a related issue (named after an Irish mathematician, Sir William Rowan Hamilton). A Hamilton path is a path through the graph 4 that visits every vertex exactly once, as opposed to an Euler path which visits every edge exactly once. A Hamilton circuit is a path that circles the entire graph once, precisely, before returning to the beginning vertex. It is NP-complete a determine whether such pathways or circuits exist.

3.1 TIME TABLE SCHEDULING: If the limits are complicated, one of the biggest problems is how to assign classes and subjects to the teachers. Graph theory is crucial to solving this issue. The available number of "p" periods in the timetable for "t" Teachers with "n" subjects must be planned. The procedure is as follows.

A bipartite graph (also known as a bigraph) is a graph whose vertices can be divided into two disjoint sets U and V such that every edge connects a vertex in U to one in V; therefore, U and V are independent sets. In the example below, the vertices of the graph are the number of teachers (t1, t2, t3, t4,....... tk) and the number of subjects (m a, m_b, m_c, m_d, ……. M_n such that the vertices are connected by „pi" edges.

It is expected that each Teacher can only teach one subject during any given period and that a maximum of one Teacher can teach each subject. Think about the first interval. The timetable for this particular period matches a matching in the graph, and each matching, in turn, matches a potential assignment of Teacher to the topics taught during that session. So, by dividing the edges of graph G into a minimum number of matchings, the timetabling problem's solution will be found. Additionally, the edges must be painted with a minimal quantity of colours.Vertex colouring algorithm is an additional method for solving this issue. "There are an equal number of vertices and edges in the line graph L(G) of G, and two vertices in L(G) are connected by an edge if the matching edges of G share a vertex. A valid vertex colouring of the line graph L(G) results in a proper edge colouring of G by the same amount of colours. Therefore, the issue can be resolved by identifying the minimally appropriate vertex colouring of L(G). Consider, for instance, that there are 4 teachers (t1, t2, t3, and t4) and 5 subjects (m-a, m-b, m-c, m-d, and m-e) that need to be taught.The teaching requirement matrix p = [pij] is given as.

P	m-a	m-b	m-c	m-d	m-e
T1	1	0	1	1	0
T2	0	1	1	0	0
T3	0	0	1	1	1
T4	1	0	0	0	1

Where a, b, c, d, e corresponds to Maths, English, Tamil, Science, social respectively.

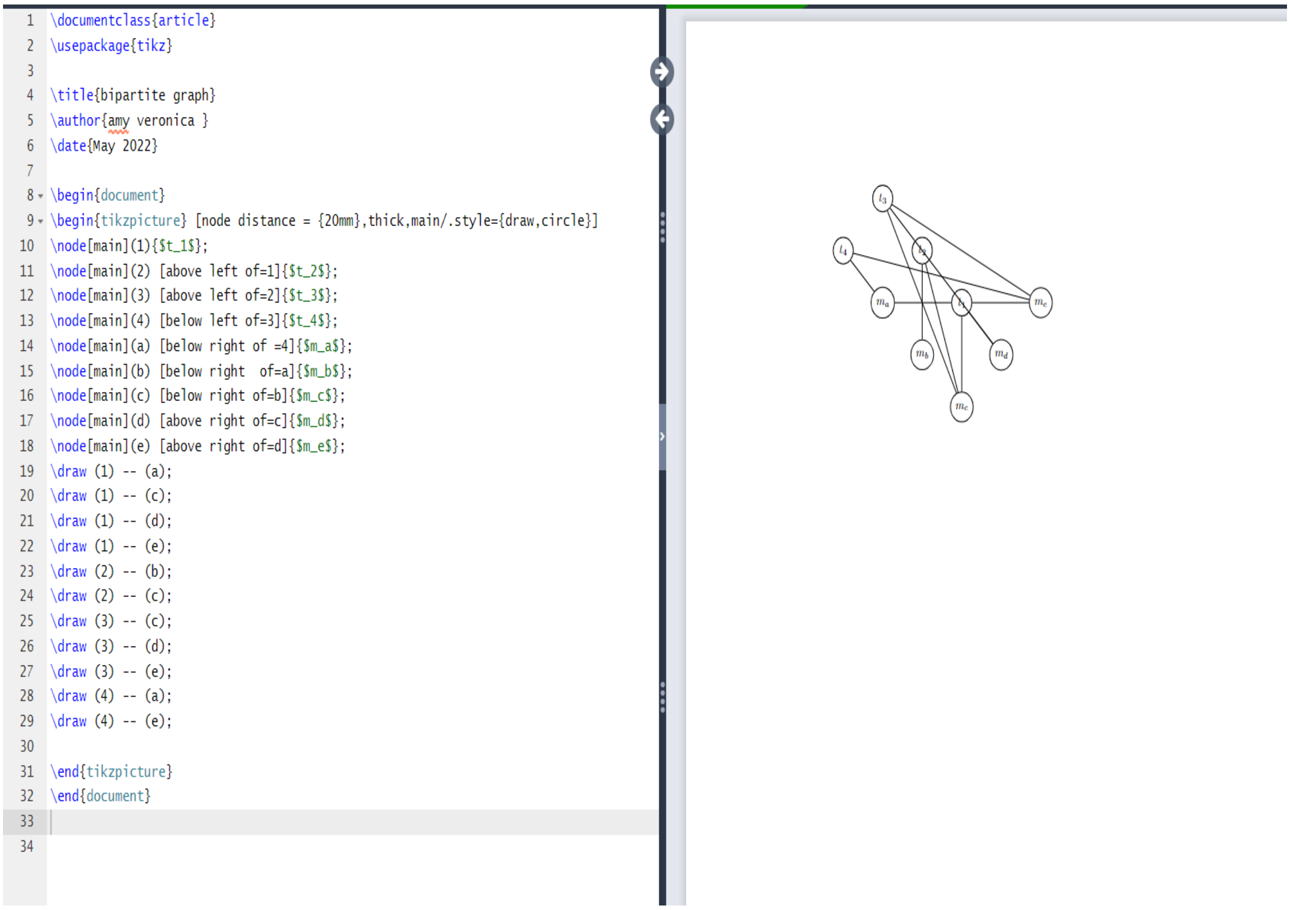
The following bipartite graph of the above table is done using LaTex commands

3.2 CODING :

```
\documentclass{article}
\usepackage{tikz}
\title{bipartite graph}
\author{amy veronica }
\date{May 2022}
\begin{document}
\begin{tikzpicture} [node distance = {20mm},thick,main/.style={draw,circle}]
\node[main](1){$t_1$};
\node[main](2) [above left of=1]{$t_2$};
\node[main](3) [above left of=2]{$t_3$};
\node[main](4) [below left of=3]{$t_4$};
\node[main](a) [below right of =4]{$m_a$};
\node[main](b) [below right  of=a]{$m_b$};
\node[main](c) [below right of=b]{$m_c$};
\node[main](d) [above right of=c]{$m_d$};
\node[main](e) [above right of=d]{$m_e$};
\draw (1) -- (a);
\draw (1) -- (c);
\draw (1) -- (d);
\draw (1) -- (e);
\draw (2) -- (b);
\draw (2) -- (c);
\draw (3) -- (c);
\draw (3) -- (d);
\draw (3) -- (e);
\draw (4) -- (a);
\draw (4) -- (e);

\end{tikzpicture}
\end{document}
```

4.1 RESULTS:



Bipartite graph with 4 Teachers and 5 subjects

5.1 CONCLUSION:

Finally, using the vertex colouring procedure, which produces the edge colouring of the bipartite multigraph G, the above-mentioned graph can be properly coloured using 4 colours. Four distinct times are represented by four colours.

	1	2	3	4
T1	m-a	m-c	m-d	m-e

The schedule for 4 subjects

Bipartite graphs have a plethora of uses in the disciplines of science, technology, engineering, and medicine. In cloud computing and cognitive radio networks, bipartite graphs and perfect matching algorithms can address a wide range of issues. Future study will concentrate on modelling issues with cognitive radio networks and cloud computing. Bipartite graph applications, particularly in the fields listed above, are rarely studied in the literature.

6.1 APPLICATIONS OF BIPARTITE GRAPH:A bipartite graph can have its vertices divided into two separate sets with each edge connecting a vertice in one set to a vertice in the other. One set of vertices defines users for the All-Electronics user purchase data, with one user per vertice. One product is defined for each vertex in the multiple set. An edge defines the user's purchase of the product by connecting them to it.

There are several uses for bipartite graphs, including the following. −

Internet search engines Search logs are stored in web search engines to record user searches and the related press-through information.(The press-through statistics reveals which pages a user clicked on after receiving results from a search.)

A bipartite graph can be used to define query and click-through data, with the two sets of vertices representing, respectively, queries and web pages.

If a person presses the web page while submitting the query, an edge links the two. On the query-web page bipartite graph, cluster analyses can be used to gather useful data.

For instance, if the press-through data for each query is the same, it can identify questions that are expressed in different languages but mean the same thingSome Web pages come together to form a directed graph, often known as the "web graph," where each page is a vertex and each link is a path from one page to another. The web graph can be clustered to recognise communities, find hubs and authoritative web pages, and spot web spam.

A social network is a type of social organisation. It can be conceptualised as a network, with individuals or organisations serving as the vertices, and friendships, shared interests, or cooperative endeavours acting as the connections between the vertices. Each user of Electronics creates a vertex in a social network, and if two users can communicate effectively, they form an edge. As a user relationship manager, it is motivated to utilise cluster analysis to find important information that can be altered from All Electronics' social web. It can obtain clusters from the network where people are familiar with one another or share friends.

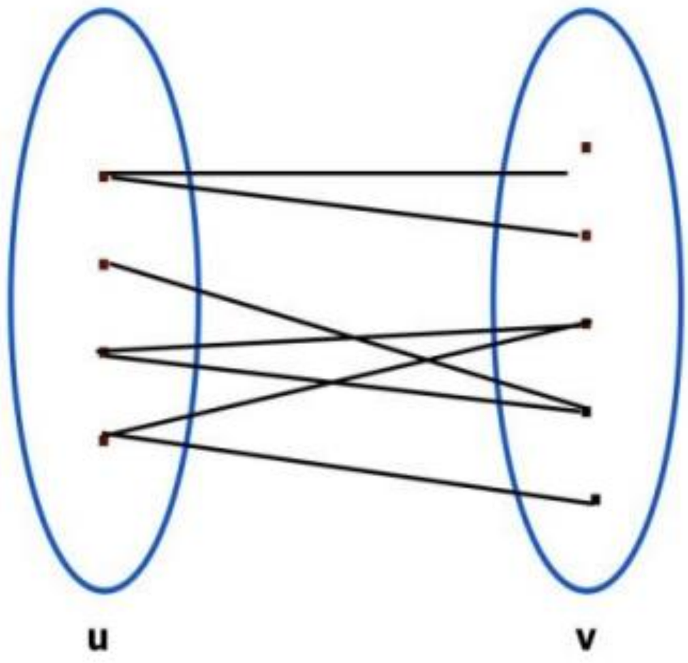
Users inside a cluster can confer with one another about making purchases. Additionally, a communication channel can be developed to guide cluster "heads" and hasten the development of promotional data.

7.1 BASE REFERENCE:

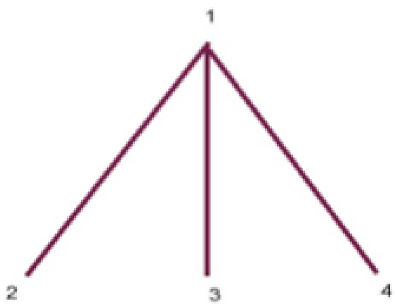
INTERNATIONAL JOURNAL OF MODERN ENGINEERING RESEARCH

Some important characterizations of bipartite graphs are as follows:

- Only when an odd cycle is absent from a graph does it qualify as being bipartite.
- • A graph is only two-colorable if it is bipartite (i.e., its chromatic number is less than or equal to 2).
- • A graph's spectrum is only symmetric if it is a bipartite graph..



Some types of Bipartite Graph and example: A graph G that can be divided into two non-empty sets, V1 and V2, such that every vertex in V1 is adjacent to every vertex in, no vertex in V1 is adjacent to a vertex in V1, and no vertex in V2 is adjacent to a vertex in V2, is said to be a complete bipartite graph. The full bipartite graph Kr is written when V1 has r vertices and V2 has s vertices. This complete bipartite network K1,3 is also known as the claw graph.



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