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An Approach of Graph Theory on Cryptography

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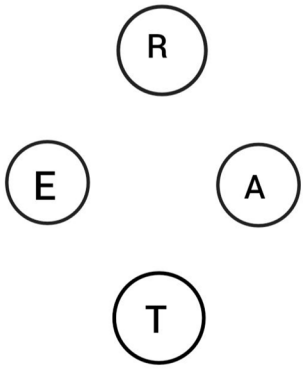
Abstract: In this paper, we discuss about the connection between graph theory and cryptography. We use the spanning tree concept of graph theory to encryption the message.
Keywords: Public key, cryptography, graphs, encryption, network security.

I. INTRODUCTION

Cryptography is the art of protect information by transforming it to unreadable format called Cipher text. The process of converting plain text to cipher text called encryption, and the process of converting cipher text on its original plain text called decryption. The remainder of this paper is a discussion of intractable problem from graph theory keeping cryptography as the base.
Firstly we represent the given text as node of the graph. Every node represent a character of the data. Now every adjacent character in the given text will be represented by adjacent vertices in the graph.

II. APPLICATION

Example :1
We will encrypt the text or data, say *RATE* , which we will be sending to the receiver on the other end.
Now we change this text into graph by converting each letter to vertices of graph.



Convert the letter to vertex(node)

To form a Cycle Graph , we link each two characters.

Further we label each edge by using the encoding table, which is followed by most researchers.

Table 1 : Encoding Table

A	B	C	D	-	-	-	-	W	X	Y	Z
1	2	3	4	-	-	-	-	23	24	25	26

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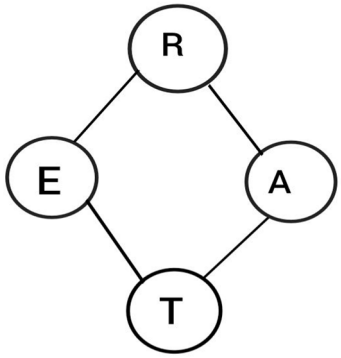
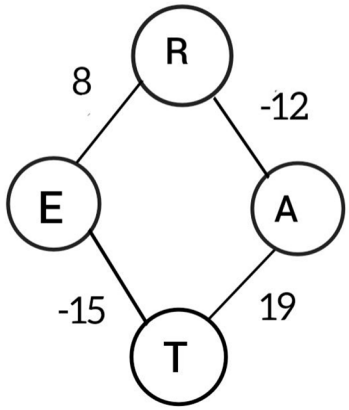
The label on each edge represents the distance between the connected two vertices from the encoding table. So the edge connecting vertex *C* with vertex *O* has a label which is distance between the two characters in the encoding table.
Distance = code (*A*)−code (*H*) = 1 − 8 = −7.
Similarly we can deduce the distances of other edges. Then we label the graph containing all the plaintext letters and we get weighted graph which is given below. After that, we keep adding edges to form a complete graph and each new added edge has a sequential weight starting from the maximum weight in the encoding table which is 26.Therefore we can add 27,28 and so on.

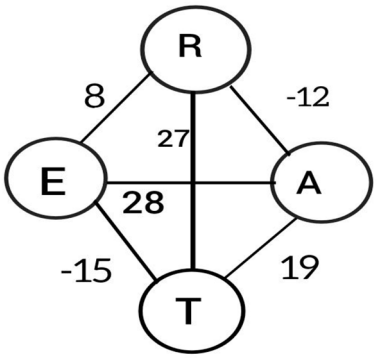


cycle Graph



Weighted Graph

Then add a special character before the first character to point to the first character, say A is special character , then we get.



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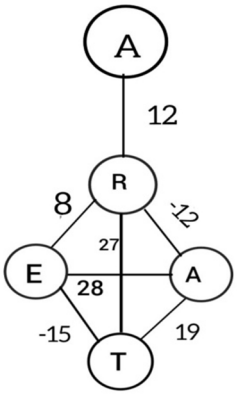


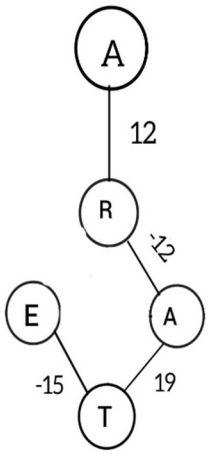
Complete plain Graph

Complete plain Graph with special character

Now represent the above graph in the form of a matrix.

$$A1 = \begin{matrix} 0 & 12 & 0 & 0 & 0 \\ 12 & 0 & -12 & 27 & 8 \\ 0 & 12 & 0 & 19 & 28 \\ 0 & 27 & 19 & 0 & -15 \\ 0 & 8 & 0 & -15 & 0 \end{matrix}$$

We now construct a minimal spanning tree of the above graph



Minimal spanning tree

$$A2 = \begin{matrix} 0 & 12 & 0 & 0 & 0 \\ 12 & 0 & -12 & 0 & 0 \\ 0 & -12 & 0 & 19 & 0 \\ 0 & 0 & 19 & 0 & -15 \\ 0 & 0 & 0 & -15 & 0 \end{matrix}$$

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A. Encryption Process

Now we store the character order in the diagonalinstead of zeroes as follows:

Table 2 :

A	H	A	T	E
0	1	2	3	4

The modified A2= 0 12 0 0 0
0 1 -12 0 0
0 -12 2 19 0
0 0 1 9 3 -15
0 0 0 -15 4

we multiply matrix A_1 by A_2 to form A^1.

A3 = A1A2 = 0 12 -144 0 0
0 288 -450 -267 437
0 144 505 363 -173
0 -201 -511 586 -60
0 8 -381 -45 225

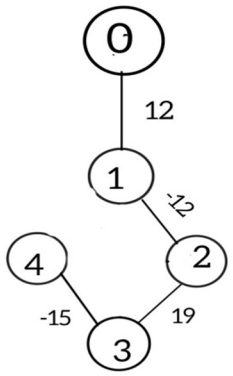
We now send the encrypted data C to the receiver -37-981 637 429 -49 -837 -637 429 -337 -387 904 8 -193 892 541 1 8 -381 -45 225.

B. Decryption Process

On the receiver side, C is got from multiplying the cipher text received with the inverse of shared Key Then calculate B by multiplying C by K−1

A3= 0 1728 2412 2112 96
0 -1809 -1293 6446 6309
0 -1103 3724 3112 4293
0 9642 11868 -14236 -10398
0 5157 5349 -10398 739

Then A_2 represent the below graph, regardless of te diagonal, we use it to retrieve the original text.



Decrypted Graph

We suppose that the vertex 0 is A, and by using encoding table
Vertex 1 = code (A) + -19 = 18, which is character R
Vertex 2 = code (H) - 7 = 1, which is character A
Vertex 3 = code (A) + 19 = 20, which is character T
Vertex 4 = code (T) + −15 = 5, which is character E
Which gives us the original text R A T E

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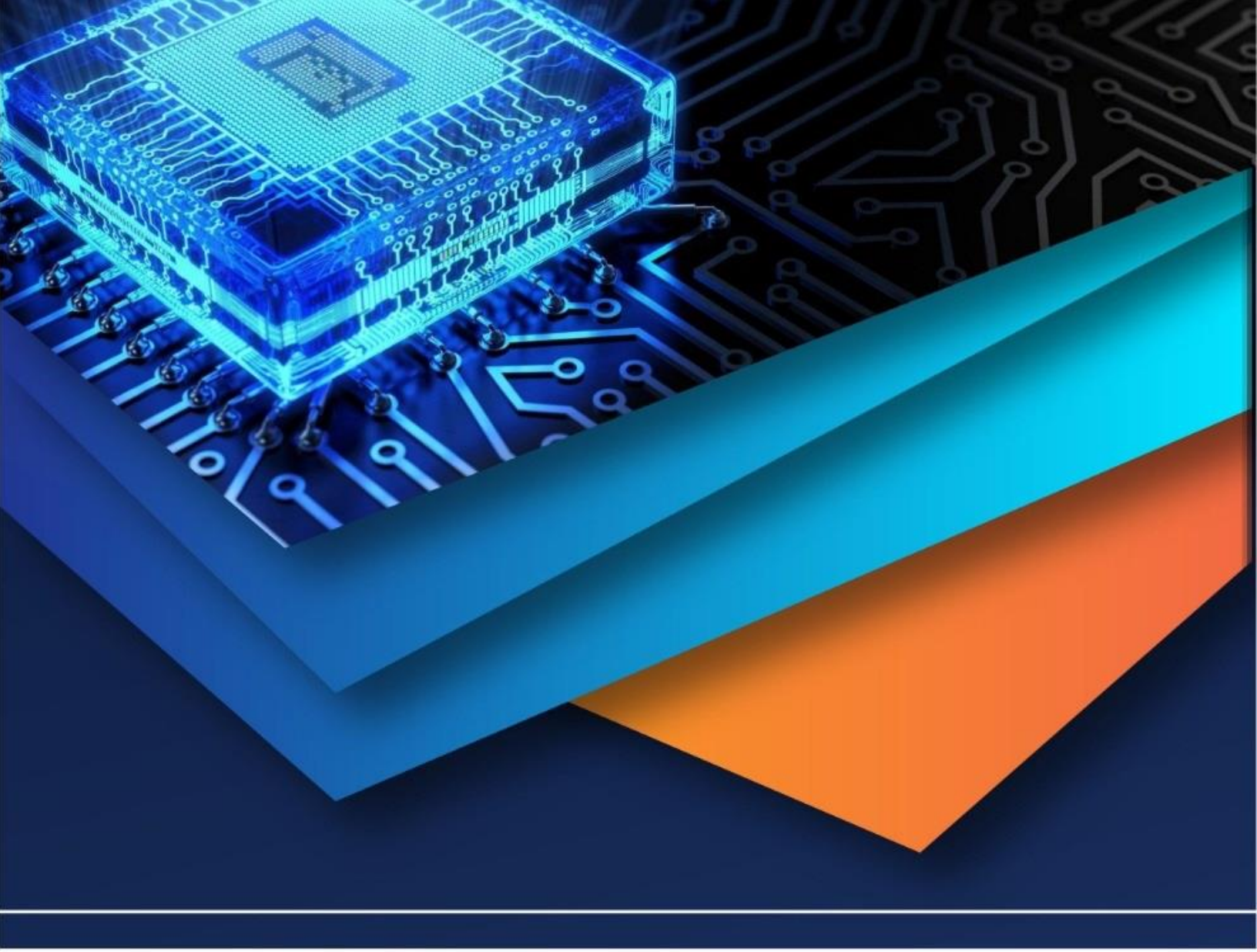

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