Experiment 3.3

Aim: *Develop a program and analyze complexity to find shortest paths in a graph with positive edge weights using Dijkstra's algorithm.*

Objectives: *Analyze to find all occurrences of a pattern P in a given string S.*

Input/Apparatus Used: *VS CODE*

Procedure/Algorithm:

- *We will first create the LPS array.*
- *Initialize two variables - 'strIdx' and 'patIdx' to iterate over the string and the pattern,respectively.*
- *If 'pat[patIdx]' equals 'str[strIdx]', we will increment both the indexes.*
- *When 'patIdx' equals the length of the pattern, this means that the pattern is found in the string. Therefore we print the index and set 'patIdx' = LPS[patIdx-1].*
- *If 'pat[patIdx]' is not equal to 'str[strIdx]', we update the patIdx witht he last index that matches with 'str[strIdx]' using the LPS array.*
- *Doing this, we will find all occurrences of the pattern in the string.*

Code:

```
#include <iostream>
#include <string>
#include <vector>
using namespace std;

void computeLPSArray(const string &pat, vector<int> &lps) {
    int M = pat.length();
    int len = 0;
    lps[0] = 0;
    int i = 1;
```

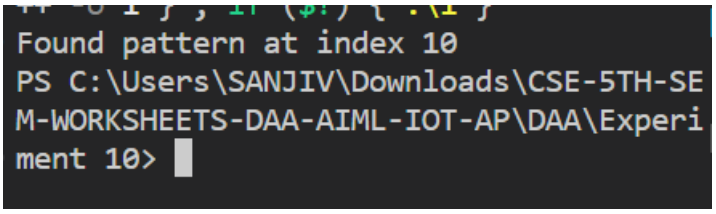
```
    while (i < M) {
        if (pat[i] == pat[len]) {
            len++;
            lps[i] = len;
            i++;
        } else {
            if (len != 0) {
                len = lps[len - 1];
            } else {
                lps[i] = 0;
                i++;
            }
        }
    }
}
void KMPSearch(const string &pat, const string &txt) {
    int M = pat.length();
    int N = txt.length();

    vector<int> lps(M);
    int j = 0;
    computeLPSArray(pat, lps);

    int i = 0;
    while (i < N) {
        if (pat[j] == txt[i]) {
            j++;
            i++;
        }
        if (j == M) {
            cout << "Found pattern at index " << i - j << endl;
            j = lps[j - 1];
```

```
        } else if (i < N && pat[j] != txt[i]) {
            if (j != 0) {
                j = lps[j - 1];
            } else {
                i = i + 1;
            }
        }
    }
}
int main() {
    string txt = "ABABDABACDABABCABAB";
    string pat = "ABABCABAB";
    KMPSearch(pat, txt);
    return 0;
}}
```

Observations/Outcome :



Time Complexity:

- *Time Complexity: Computing the LPS array takes O(M) time. The time complexity of the KMP algorithm is O(N + M). Here 'N' is the length of the string, and 'M' is the length of the pattern.*