## Assignment No : 6

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**Class :** BTech
**Sub :** HPC Lab

**Title of practical: Implementation of OpenMP programs.**

Implement following Programs using OpenMP with C:

1. Implementation of Matrix-Matrix Multiplication.

matrix_multiplication.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <omp.h>

void matrix_matrix_multiply(int **A, int **B, int **C, int N) {
    #pragma omp parallel for
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            C[i][j] = 0;
            for (int k = 0; k < N; k++) {
                C[i][j] += A[i][k] * B[k][j];
            }
        }
    }
}

int** allocate_matrix(int N) {
    int **matrix = (int **)malloc(N * sizeof(int *));
    for (int i = 0; i < N; i++) {
        matrix[i] = (int *)malloc(N * sizeof(int));
    }
    return matrix;
}

void initialize_matrix(int **matrix, int N) {
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            matrix[i][j] = rand() % 10;
        }
    }
}

void free_matrix(int **matrix, int N) {
    for (int i = 0; i < N; i++) {
        free(matrix[i]);
    }
    free(matrix);
}
```

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS

vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$
  * History restored

vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ gcc -o hello -fopenmp matrix_multiplication.c
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ ./hello
Matrix-Matrix Multiplication Time: 15.066441 seconds
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$
```

2. Implementation of Matrix-vector Multiplication.

C matrix_vector_multiplication.c > ...

```c
#include <stdio.h>
#include <stdlib.h>
#include <omp.h>

void matrix_vector_multiply(int **A, int *x, int *y, int N) {
    #pragma omp parallel for
    for (int i = 0; i < N; i++) {
        y[i] = 0;
        for (int j = 0; j < N; j++) {
            y[i] += A[i][j] * x[j];
        }
    }
}

int** allocate_matrix(int N) {
    int **matrix = (int **)malloc(N * sizeof(int *));
    for (int i = 0; i < N; i++) {
        matrix[i] = (int *)malloc(N * sizeof(int));
    }
    return matrix;
}

int* allocate_vector(int N) {
    return (int *)malloc(N * sizeof(int));
}

void initialize_matrix(int **matrix, int N) {
    for (int i = 0; i < N; i++) {
        for (int j = 0; j < N; j++) {
            matrix[i][j] = rand() % 10;
        }
    }
}

void initialize_vector(int *vector, int N) {
    for (int i = 0; i < N; i++) {
        vector[i] = rand() % 10;
    }
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ gcc -o hello -fopenmp matrix_multiplication.c
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ ./hello
Matrix-Matrix Multiplication Time: 15.066441 seconds
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ gcc -o hello -fopenmp matrix_vector_multiplication.c
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$ ./hello
Matrix-Vector Multiplication Time: 0.012888 seconds
vaishnavi@vaishnaviVM:~/Desktop/22520001/Assign6$
```