LAB VI

1. Create a data file **vecu.dat** with data for vector **u** and a data file **vecv.dat** with data for vector **v**. In each data file, the first line contains the dimension of the vector and the next line contains the components of the vector. Write a C program that does the following: It reads the dimensions and components of the vectors and then prints the vectors in the terminal. It then calculates the length of the vectors and the angle between the vectors (if the dimensions of the vectors are same). Finally, it writes the length of the vectors and the angle between the vectors (if exists) in a file **output.dat**.
   Expected input: See **vecu.dat** and **vecv.dat**

   Expected output: See **output.dat**

2. Write a C program that generates 100 random numbers between -0.5 and 0.5 and writes them in a file **ran.dat**. The first line of **ran.dat** contains the number of data and the next 100 lines contain the 100 random numbers.
   Expected output: Depends on the program

3. Write a C program that reads the data from the file **ran.dat** (created above) and computes the average of the data. It also finds the number of data above the average value.
   Expected output: Depends on the program

4. Consider a hypothetical grading system for course MTH409. Let μ be the average and σ be the standard deviation of the marks (integers) obtained by the students. The following table shows the grading criteria followed by the instructor.

Marks	Grade
$\geq \mu + \frac{5}{3}\sigma$	A*
$[\mu + \frac{4}{3}\sigma,\ \mu + \frac{5}{3}\sigma)$	A
$[\mu + \sigma,\ \mu + \frac{4}{3}\sigma)$	B+
$[\mu + \frac{2}{3}\sigma,\ \mu + \sigma)$	B
$[\mu + \frac{1}{3}\sigma,\ \mu + \frac{2}{3}\sigma)$	C+
$[\mu,\ \mu + \frac{1}{3}\sigma)$	C
$[\mu - \frac{1}{3}\sigma,\ \mu)$	D+
$[\mu - \frac{2}{3}\sigma,\ \mu - \frac{1}{3}\sigma)$	D
$[\mu - \sigma,\ \mu - \frac{2}{3}\sigma)$	E
$\leq \mu - \sigma$	F

   Write a C program that reads the data from the file **mark.dat** whose first line contains the number of students followed by the marks. The program then write the grades corresponding to the marks in a file **grade.dat**. The program should be able to handle at most 100 students. $\Big($For n observations, $x_1, x_2, \cdots, x_n$, its standard deviation is defined by $\sigma = \sqrt{\sum_{i=1}^{n}(x_i - \mu)^2/n}.\Big)$

   Expected input: See **mark.dat**

   Expected output: See **grade.dat**

5. Write a C program that performs multiplication $B = AX$ of a real matrix A with a real column vector X if the matrix-vector multiplication is compatible. The maximum order of the matrix is 100×100 and that of the column vector is 100. Create a data file **matA.dat** with data for the matrix A whose first line contains actual row and column dimensions of A followed by the matrix arranged row-wise. Also, create a data file **vecX.dat** with data for column vector X whose first line contains actual order of X followed by its components. Implement the following in the program:

   (a) It reads the matrix A from the file matA.dat and prints the matrix A in the terminal

(b) It reads the column vector X from the file vecX.dat and prints X in the terminal

(c) It implement matrix-vector multiplication using a function

(d) It prints B in the terminal as well as in a file vecB.dat. The first line of vecB.dat contains the actual order of B followed by the components.

Expected input: See **matA.dat** and **vecX.dat**

Expected output: See **vecB.dat**

6. Write a C program that performs matrix multiplication $C = AB$ of two real matrices A and B if the matrix multiplication is compatible. The maximum order of the matrices are 100×100. Create a data file **matA.dat** with data for the matrix A whose first line contains actual row and column dimensions of A followed by the matrix arranged row-wise. Similarly, create a data file **matB.dat** for the matrix B. Implement the following in the program:

   (a) It reads the matrix A from the file matA.dat and prints the matrix A in the terminal

   (b) It reads the matrix B from the file matB.dat and prints the matrix B in the terminal

   (c) It implement matrix multiplication using a function

   (d) It prints the matrix C in the terminal as well as in a file matC.dat. The first line of matC.dat contains actual row and column dimensions of C followed by the matrix arranged row-wise.

   Expected input: See **matA.dat** and **matB.dat**

   Expected output: See **matC.dat**

7. Monte Carlo simulations are used to find the probability of different outcomes in a process. Write a C program (using Monte Carlo technique) that finds the probability of 5 heads if a coin is tossed 10 times. Also, do the same for 4 heads or five heads if a coin is tossed 10 times. [To find the probability of 5 heads, we carry n number trials and a coin is tossed 10 time in each trial. Let m be the number of trials in which 5 heads appear. Then the required probability is m/n]. The probability of 5 heads out of 10 toss is

$$\binom{10}{5}\frac{1}{2^{10}} = 0.24609375$$

   and the probability of the later event is

$$\binom{10}{5}\frac{1}{2^{10}} + \binom{10}{4}\frac{1}{2^{10}} = 0.451171875.$$

   The output depends on the no. of trial and the random number generator. Here is one typical input and output.

   Test data and expected output:

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Enter the number of trial: 2000
Probability of five heads is = 0.2430
Probability of five heads or four is = 0.4525
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