Programming Assignment – A

Submit your assignment as a report. You need to do the following for each of the problems to get full points.

1) **Describe the workings of your code and challenges that you encountered during your program development. [3 points]**
2) **Program listing with line numbers. [10 points]**
3) **Create test cases and report their output. [7 points]**

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1. Quadratic Equation [20 points]

Design and write a Java code that solves a quadratic equation $ax^2 + bx + c = 0$. Please use class and object definitions and do not use procedural style. Let the roots of $ax^2 + bx + c = 0$ be p and q. Show that the following:

$$p + q = -\frac{b}{a}$$

and

$$pq = \frac{c}{a},$$

for non-trivial of values of a, b, c. Make sure that you address that complex numbers as objects.

2. Matrix Operations [20 points]

You will create a general NxM matrix where N = number of rows and M = number columns that are specified by the user. Write a generic class of matrix that accepts user-defined N and M as input parameters and generates a random matrix. Each cell of the matrix is a random number.

Example 1: Consider a 2x2 matrix: A = $\begin{pmatrix} 23 & 54 \\ 98 & 97 \end{pmatrix}$ where A[i][j] is a random number between (0,99).

Example 2: Consider a 3x3 matrix A = $\begin{pmatrix} 54 & 43 & 76 \\ 12 & 98 & 34 \\ 38 & 43 & 62 \end{pmatrix}$ where A[i][j] is a random number between (0,99).

Thus generate a random matrix **A**. Similarly you can generate matrices of other dimensions by specifiying user values N and M. Perform your operations on these matrices.

Design and write Java codes that solves the following:

- Matrix Addition (2x2, 3x5)
- Matrix Multiplication (2x2, 3x5)

Show your results with at least two examples of each.

3. Sorting [20 points]

1. Implement the Quicksort algorithm in Java code
2. Suggest creative and original variations that can make this algorithm better. It should have Java code of your tryouts.

4. Numbers and Binary Strings [20 points]

1) Print all n-digit strictly increasing numbers

Given number of digits n in a number, print all n-digit numbers whose digits are strictly increasing from left to right.

Examples:

Input: n = 1
Output: 0 1 2 3 4 5 6 7 8 9

Input: n = 2
Output:
01 02 03 04 05 06 07 08 09 12 13 14 15 16 17 18 19 23 24 25 26 27 28 29 34 35 36 37 38 39 45 46 47 48 49 56 57 58 59 67 68 69 78 79 89

2) Generate all binary strings without consecutive 1's

Given number n print all binary string of size n where all the binary strings do not have consecutive ones.

Examples:

Input : K = 3
Output : 000 , 001 , 010 , 100 , 101

Input : K = 4
Output :0000 0001 0010 0100 0101 1000 1001 1010

5. Dictionary [20 points]

Design and implement a scalable dictionary that stores an English word and its meanings using linked lists or trees or both. When you query a word later on it should return you the associated meanings. Implement a Java program. Please suggest a creative solution.

Example:

Store: Apple => fruit, computer

Query: Apple?

Answer: fruit, computer