Lab Problem: 05.

Course code: CCE-312.
Course Title: Numerical Methods sessional.

Name of the Lab Report: Solve Real world problem and Simul equation using Cramer's rule after that implement it by Python.

Remarks & Signature:

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1. **A total of 8,500 taka was invested in three interest earning accounts. The interest rates were 2%,3% and 6% if the total simple interest for one year was 380 taka and the amount invested at 6% was equal to the sum of the amounts in the other two accounts, then how much was invested in each account? (Use Cramer's rule) and implement with python.**

   Let the amounts invested in the three accounts be Tk. x, Tk. y and Tk. z
   Interest for the three accounts are (2/100)x, (3/100)y and (6/100)z
   According to the problem,
   x + y + z = 8500 ………………………………………………… (1)
   (2/100)x + (3/100)y + (6/100)z (or) multiplying by 100,
   2x + 3y + 6z = 38000 …………………………………………. (2)
   z = x + y or x + y - z = 0... (3)

$$\text{Now,}\quad \Delta = \begin{vmatrix} 1 & 1 & 1 \\ 2 & 3 & 6 \\ 1 & 1 & -1 \end{vmatrix} \begin{aligned} &= 1\,(-3-6) - 1\,(-2-6) + 1\,(2-3) \\ &= -9+8-1 \\ &= -2 \neq 0 \end{aligned}$$

So there exists a unique solution to the system (1), (2) and (3)

$$\Delta_x = \begin{vmatrix} 8500 & 1 & 1 \\ 38000 & 3 & 6 \\ 0 & 1 & -1 \end{vmatrix} \begin{aligned} &= 8500\,(-3-6) - 1(-38000) + 1\,(38000) \\ &= -76500 + 76000 \\ &= -500 \end{aligned}$$

$$\Delta_y = \begin{vmatrix} 1 & 8500 & 1 \\ 2 & 38000 & 6 \\ 1 & 0 & -1 \end{vmatrix} \begin{aligned} &= 1\,(-38000) - 8500\,(-2-6) + 1(-38000) \\ &= -38000 + 68000 - 38000 \\ &= -8000 \end{aligned}$$

$$\Delta_z = \begin{vmatrix} 1 & 1 & 8500 \\ 2 & 3 & 38000 \\ 1 & 1 & 0 \end{vmatrix} \begin{aligned} &= 1\,(-38000) - 1\,(-38000) + 8500\,(2-3) \\ &= -38000 + 38000 - 8500 \\ &= -8500 \end{aligned}$$

So by Cramer's rule,

$$x = \frac{\Delta_x}{\Delta} = \frac{-500}{-2} = 250,\ y = \frac{\Delta_y}{\Delta} = \frac{-8000}{-2} = 4000,\ z = \frac{\Delta_z}{\Delta} = \frac{-8500}{-2} = 4250$$

Thus the amount invested at 2% is Tk. 250, at 3% is Tk. 4000 and at 6% is Tk. 4250.

✪ **Implement using Python:**

```
import numpy as np

coefficients = np.array([[1, 1, 1],
                         [2, 3, 6],
                         [1, 1, -1]])

constants = np.array([8500, 38000, 0])

det_coefficients = np.linalg.det(coefficients)


coefficients_x = coefficients.copy()
coefficients_x[:, 0] = constants

coefficients_y = coefficients.copy()
```

```
    coefficients_y[:, 1] = constants

    coefficients_z = coefficients.copy()
    coefficients_z[:, 2] = constants


    det_x = np.linalg.det(coefficients_x)
    det_y = np.linalg.det(coefficients_y)
    det_z = np.linalg.det(coefficients_z)


    solution_x = det_x / det_coefficients
    solution_y = det_y / det_coefficients
    solution_z = det_z / det_coefficients

    print("Solution:")
    print(f"x = {solution_x}")
    print(f"y = {solution_y}")
    print(f"z = {solution_z}")
```

- Using Cramer's rule solve the following after that implement it using Python.

$.3x_1+.52x_2+x_3=0.01$

$.5x_1+.3x_2+.5x_3=.67$

$.1x_1+.3x_2+.5x_3=-.44$

Sol^n: Let us write these equations in the form AX=B

$$\begin{bmatrix} .3 & .52 & 1 \\ .5 & .3 & .5 \\ .1 & .3 & .5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} .01 \\ .67 \\ -.44 \end{bmatrix}$$

$$D=|A|=\begin{vmatrix} .3 & .52 & 1 \\ .5 & .3 & .5 \\ .1 & .3 & .5 \end{vmatrix}=.3(.5x.3-.5x.3)-.52(.5x.5-.5x.1)+1(.5x.3-.3x.1)=0.016$$

$$Dx_1=\begin{vmatrix} .01 & .52 & 1 \\ ..67 & .3 & .5 \\ -.44 & .3 & .5 \end{vmatrix}=0.0444$$

$$Dx_2=\begin{vmatrix} .3 & .01 & 1 \\ .5 & .67 & .5 \\ .1 & -.44 & .5 \end{vmatrix}= -0.1255$$

$$Dx_3 = \begin{vmatrix} .3 & .52 & .01 \\ .5 & .3 & .67 \\ .1 & .3 & -.44 \end{vmatrix}=0.05054$$

X_1= Dx_1/D=0.0444/0.016=2.775

X_2= Dx_2/D=-0.1255/0.016=-7.84375

X_3= Dx_3/D=0.05054/0.016=3.158

✪ **Implement using python:**

```
✪import numpy as np
  coefficients = np.array([[0.3, 0.52, 1],
                           [0.5, 0.3, 0.5],
                           [0.1, 0.3, 0.5]])

  constants = np.array([0.01, 0.67, -0.44])

  det_coefficients = np.linalg.det(coefficients)

  coefficients_x = coefficients.copy()
  coefficients_x[:, 0] = constants

  coefficients_y = coefficients.copy()
  coefficients_y[:, 1] = constants

  coefficients_z = coefficients.copy()
  coefficients_z[:, 2] = constants

  det_x = np.linalg.det(coefficients_x)
  det_y = np.linalg.det(coefficients_y)
  det_z = np.linalg.det(coefficients_z)


  solution_x = det_x / det_coefficients
  solution_y = det_y / det_coefficients
  solution_z = det_z / det_coefficients

  print("Solution:")
  print(f"x = {solution_x}")
  print(f"y = {solution_y}")
  print(f"z = {solution_z}")
```