

1. **Pattern Printing:** Write a program `<roll_no>_asg1.c` to print a diamond structure of a size given as input.

Example:

Case 1:

Enter the size of the diamond:

4

```
  1
 2 2
3 3 3
4 4 4 4
 3 3 3
  2 2
   1
```

Case 2:

Enter a number:

5

```
  1
 2 2
3 3 3
4 4 4 4
5 5 5 5 5
 4 4 4 4
  3 3 3
   2 2
    1
```

2. Bisection Method: The bisection method for computing the roots of a function $f(x)$ works as follows. It starts with two given values a and b , such that $f(a)$ and $f(b)$ have opposite signs (that is $f(a) \times f(b)$ is negative). It then searches for a root between $x=a$ and $x=b$ as follows:

1. If $|b - a| < 0.01$ then stop and print b as the root and terminate
2. Otherwise, let $c = (a+b)/2$
 - 2.1. If $f(c) = 0$, then print c as the root and terminate
 - 2.2. If $f(c)$ and $f(a)$ have the same sign then let $a \leftarrow c$ else let $b \leftarrow c$
 - 2.3. Goto Step 1.

Note that in the above we find the root with a precision of two decimal places, which is guaranteed because we terminate when $|b - a|$ is less than 0.01.

Write a program <roll_no>_asg2.c to use the above method to find the roots of the following functions in the intervals indicated:

$$F1(x) = x^3 - 14x^2 + 35x + 50 \quad \text{Intervals: } [-15, -10], [10, 20], [0, 5], [-8, 0]$$

$$F2(x) = x^2 - 12x - 805 \quad \text{Intervals: } [0, 10], [-50, 0], [50, 70], [20, 40]$$

$$F3(x) = x^4 - 54x^3 + 1048x^2 - 8586x + 24871 \quad \text{Intervals: } [0, 10], [-10, 0], [-12, -18], [25, 75]$$

Your program must have separate functions for evaluating the value of each of $F1(x)$, $F2(x)$, $F3(x)$ for a given value of x . Print the root in each interval for the respective function, if any, else print "no roots exist".

3. Numerical Method for Integration. The trapezoidal method for computing the integral of a function $f(x)$ between two bounds, $x=a$, and $x=b$, works as follows.

1. We split the interval $[a, b]$ into equal segments of length 0.01. For example, if $a=2$ and $b=5$, then we have segments, $[2, 2.01]$, $[2.01, 2.02]$... $[4.98, 4.99]$, $[4.99, 5]$.
2. For each segment $[m, n]$ we compute the area of the trapezoid having corners: $(m, 0)$, $(n, 0)$, $(m, f(m))$, and $(n, f(n))$.
3. Area above the x-axis is treated as positive, while area below the x-axis is negative
4. Add the areas of all the trapezoids.

Write a program `<roll_no>_asg3.c` to find the definite integral value of the following function using the trapezoidal rule:

$$f(x) = \int_a^b (x^2 + x)dx$$

You have to take lower bound (a) and upper bound (b) as input as well as the value of dx.

You have to print the integral value **up to four decimal places**.

Example:

Case 1:

Enter upper bound:

5

Enter Lower bound:

10

Enter value of dx:

0.1

Definite Integral value is: 329.1750

Case 2:

Enter upper bound:

15.5

Enter Lower bound:

25.5

Enter value of dx:

0.5

Definite Integral value is: 4491.2500

4. **Ramanujan's Taxi Cab Number:** S. Ramanujan was an Indian mathematician who became famous for his intuition for numbers. When the English mathematician G. H. Hardy came to visit him in the hospital one day, Hardy remarked that the number of his taxi was 1729, a rather dull number. To which Ramanujan replied, "No, Hardy! No, Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways."

Verify this claim by writing a program, `<roll_no>_asg4.c`, that reads an integer, N , and prints out all integers less than or equal to N that can be expressed as the sum of two cubes in two different ways - find distinct positive integers $a, b, c,$ and d such that $a^3 + b^3 = c^3 + d^3$. Use four nested for loops.

Example:

Case 1:

Enter the range value:

100

No Taxicab number within 100.

Case 2:

Enter the range value:

10000

Taxicab number within 10000 are:

1729: ((1, 12), (9, 10))

Case 3:

Enter the range value:

100000000

Taxicab number within 100000000 are:

87539319: ((167, 463), (228, 423))

Or

87539319: ((167, 463), (255, 414))

Or

87539319: ((228, 423), (255, 141))