

## TITLE: TO FIND FINITE INTEGRATION OF A FUNCTION USING NEWTON COTES'S FORMULA

### Definition:

The **Newton-Cotes formula** is a numerical integration method that approximates the integral of a function by evaluating the function at equally spaced points and fitting a polynomial through these points to estimate the area under the curve.

### Algorithm for Newton Cotes Formula:

#### 1. Input:

- Function  $f(x)$  to integrate.
- Lower limit  $a$ .
- Upper limit  $b$ .
- Number of subintervals  $n$  (equal to  $b$  in the code).

#### 2. Initialization:

- Calculate step size  $h = \frac{b-a}{n}$ .
- Generate  $n + 1$  equally spaced points  $x_i = a + (i - 1) \times h$  for  $i = 1$  to  $n + 1$ .
- Evaluate the function at these points to get  $y_i = f(x_i)$ .

#### 3. Integration using different Newton-Cotes rules:

##### • Trapezoidal Rule:

- Approximate integral as

$$I = \frac{h}{2} \left( y_1 + y_{n+1} + 2 \sum_{i=2}^n y_i \right)$$

##### • Simpson's 1/3 Rule:

- Approximate integral as

$$I = \frac{h}{3} \left( y_1 + y_{n+1} + 4 \sum_{\text{even } i} y_i + 2 \sum_{\text{odd } i} y_i \right)$$

##### • Simpson's 3/8 Rule:

- Approximate integral as

$$I = \frac{3h}{8} \left( y_1 + y_{n+1} + 3 \sum_{i \not\equiv 1 \pmod{3}} y_i + 2 \sum_{i \equiv 1 \pmod{3}} y_i \right)$$

### Code:

```
%Title:-
% To find finite integration of a function using Newton's Cotes Quadrature
% Formula
%Date: July 10,2025
%-----Three critical statements-----
close all;
clear variables;
clc;
%----- User I/P section -----
func = input('Enter function f(x)=');
f = inline(func);
%----- User I/P section -----
a = input('Enter lower limit a =');
b = input('Enter upper limit b =');
```

```

n = b;
h = (b-a)/n;
x = zeros(1, n+1);
y = zeros(1, n+1);
x(1) = a;
y(1) = f(x(1));
for i=2:n+1
    x(i) = x(1) + (i-1) * h;
    y(i) = f(x(i));
end
out = [x;y];
disp(out);
%----- Calculation section -----
%----- Trapezoidal Rule -----
I = 0;
for i = 2:n
    I = I + 2*y(i);
end
I = h/2*(y(1) + y(n+1) + I);
result = strcat('The integration by Trapezoidal rule is I = ', num2str(I));
disp('_____');
disp(result);

%----- Simpsons 1/3 Rule -----
I = 0;
for i = 2:n
    if(mod(i,2) == 0)
        I = I + 4*y(i);
    else
        I = I + 2*y(i);
    end
end
I = h/3*(y(1) + y(n+1) + I);
result = strcat('The integration by Simpsons 1/3 rule is I = ', num2str(I));
disp(result);

%----- Simpsons 3/8 Rule -----
I = 0;
for i = 2:n
    if(mod(i-1,3) == 0)
        I = I + 2*y(i);
    else
        I = I + 3*y(i);
    end
end
I = (3*h)/8*(y(1) + y(n+1) + I);
result = strcat('The integration by Simpsons 3/8 rule is I = ', num2str(I));
disp(result);

```

## Output:

```

Command Window

'1/(1+x^2)'
Enter lower limit a =
0
Enter upper limit b =
6

      0      1.0000      2.0000      3.0000      4.0000      5.0000      6.0000
1.0000      0.5000      0.2000      0.1000      0.0588      0.0385      0.0270

The integration by Trapezoidal rule is I =1.4108
The integration by Simpsons 1/3 rule is I =1.3662
The integration by Simpsons 3/8 rule is I =1.3571
>>

```

## Conclusion:

Newton-Cotes formulas allow us to numerically estimate definite integrals by evaluating the function at equally spaced points and applying polynomial-based rules. This practical demonstrates their effectiveness for approximating finite integrals when exact solutions are difficult.