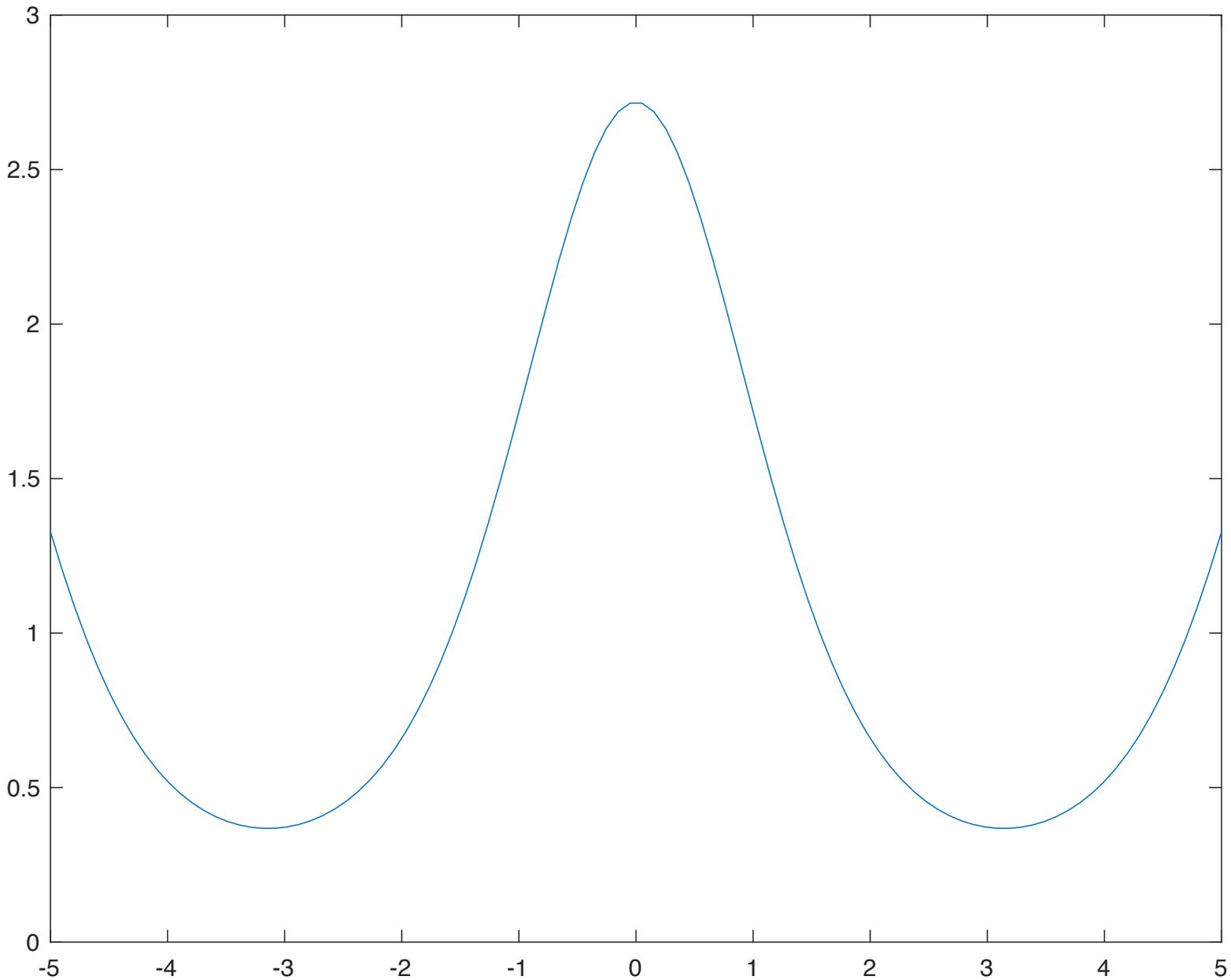
Numerical Integration

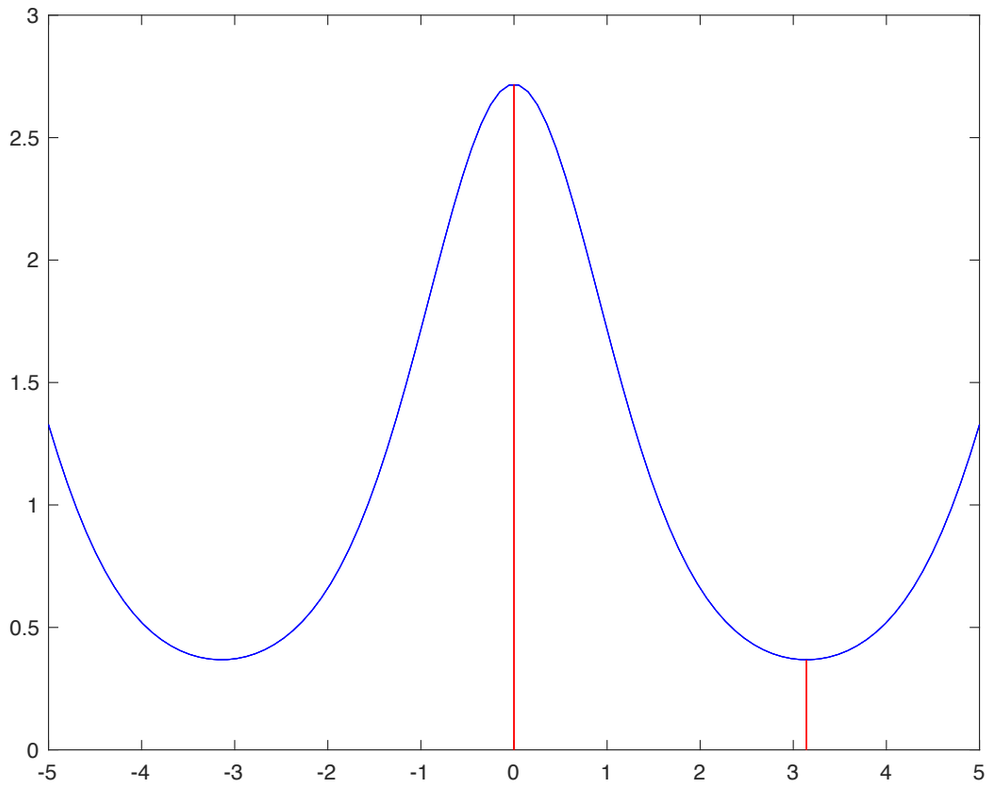
```
>> f = inline('exp(cos(x))');
>> z = linspace(-5,5);
>> plot(z,f(z))
```



```
% Draw function exp(cos(x)) and
% apply integral to find its definite integration from 0 to pi
```

```
f = inline('exp(cos(x))');
Z = linspace(-5,5);
plot(Z,f(Z),'b'); hold on
plot([0 0],[0 f(0)],'r');
plot([pi pi],[0 f(pi)],'r');

ans = integral(@(x) exp(cos(x)),0,pi);
fprintf('%18.17f\n',ans);
```

3.97746326050642285



% Apply indefinite integration to calculate definite integration

$$\int_0^{\pi} exp(cos(x))dx = ?$$

```
str = 'exp(cos(x))';
F= inline(int([redacted]))
fprintf('%18.17f\n',[redacted]);
```

```
3.97746326050642285
```

% apply integral to calculate definite integration
% of exp(cos(x)) from 0 to pi

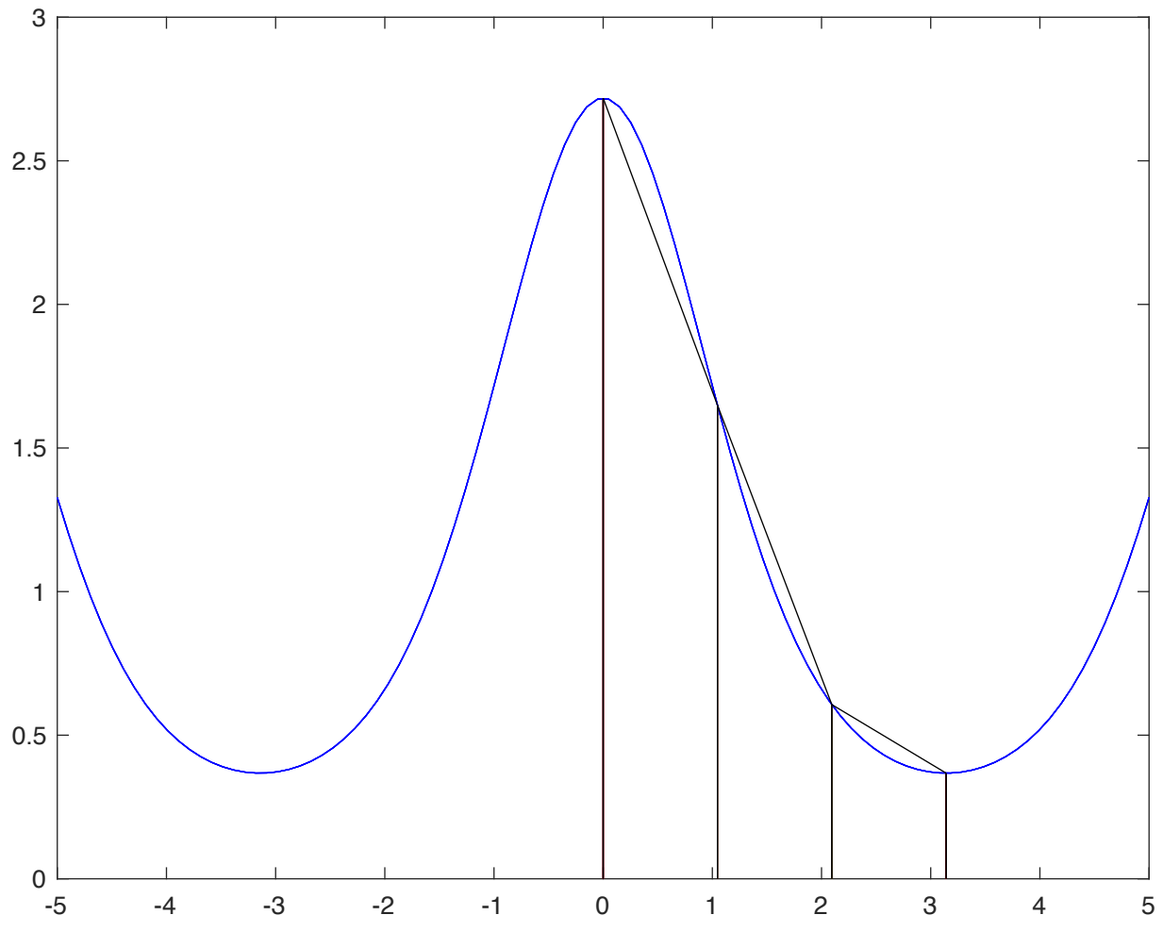
```
1 -    ans = integral(@(x)                    )
2 -    fprintf('%18.17f\n',ans);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
>> untitled2

ans =

    3.9775

3.97746326050642285
```

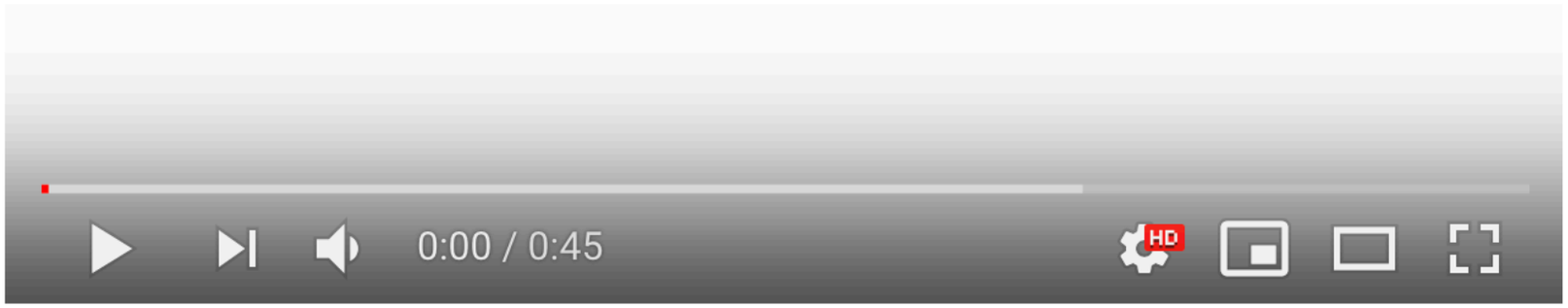
```
% partition the range [a, b] to a mesh of n knots
% Draw Trapezoids

f = inline('exp(cos(x))');
z = linspace(-5,5);
plot(z,f(z),'b'); hold on

a = 0; b = pi;
ans = integral(@(x) exp(cos(x)),a,b);
fprintf('%18.17f\n',ans);

n = 4;
pp = [redacted];
for i = 1 : n
    plot([pp(i) pp(i)],[0 f(pp(i))],'k');
end
for i = 1 : n-1
    plot([pp(i) pp(i+1)],[redacted],'k');
end
```



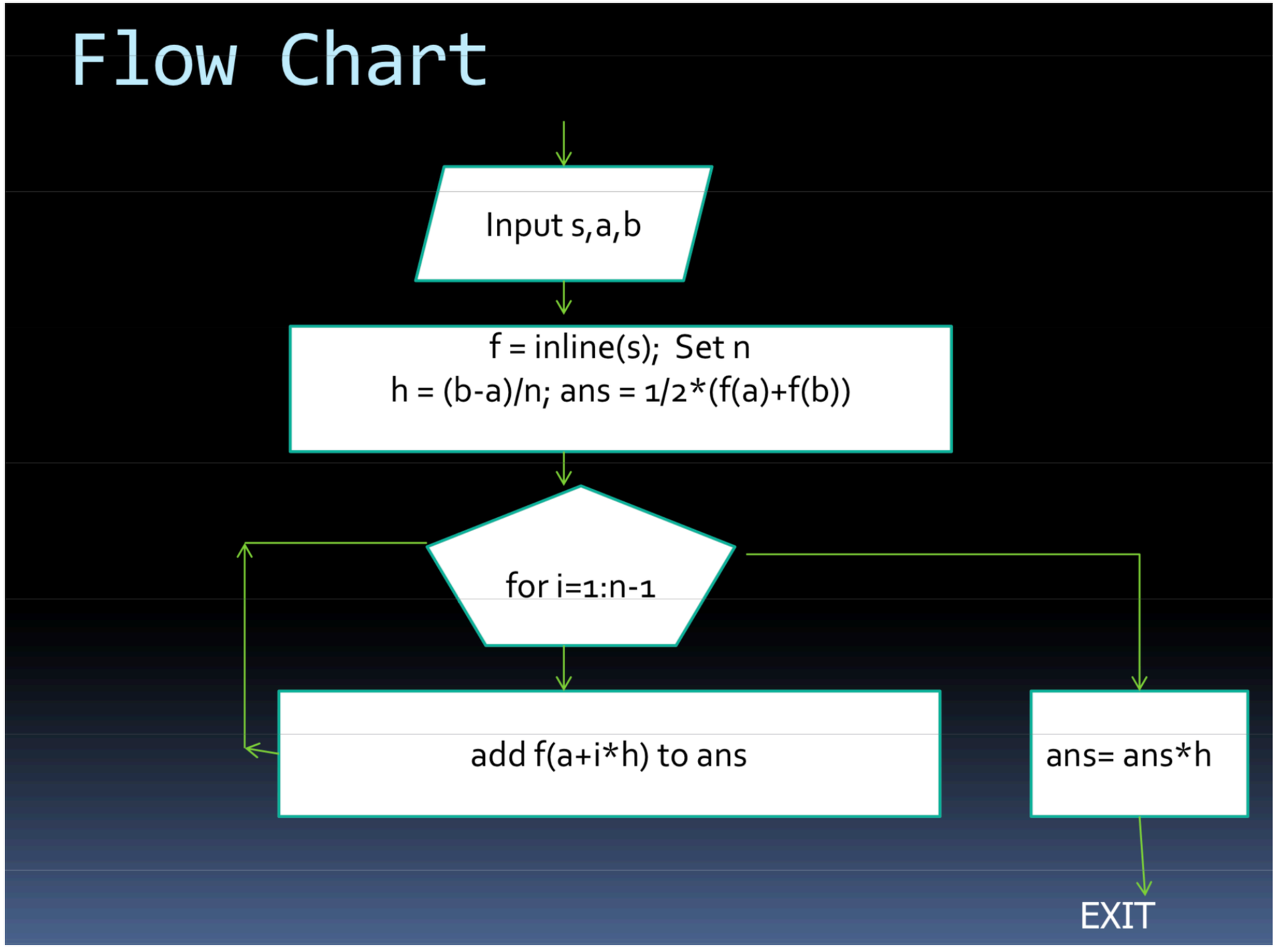
https://youtu.be/Y72JQu_JGxE

Problem 2. Implement the composite Trapezoid rule

```
s='exp(cos(x))';
f=inline(s);
a=0;
b=2*pi;
.
.
```



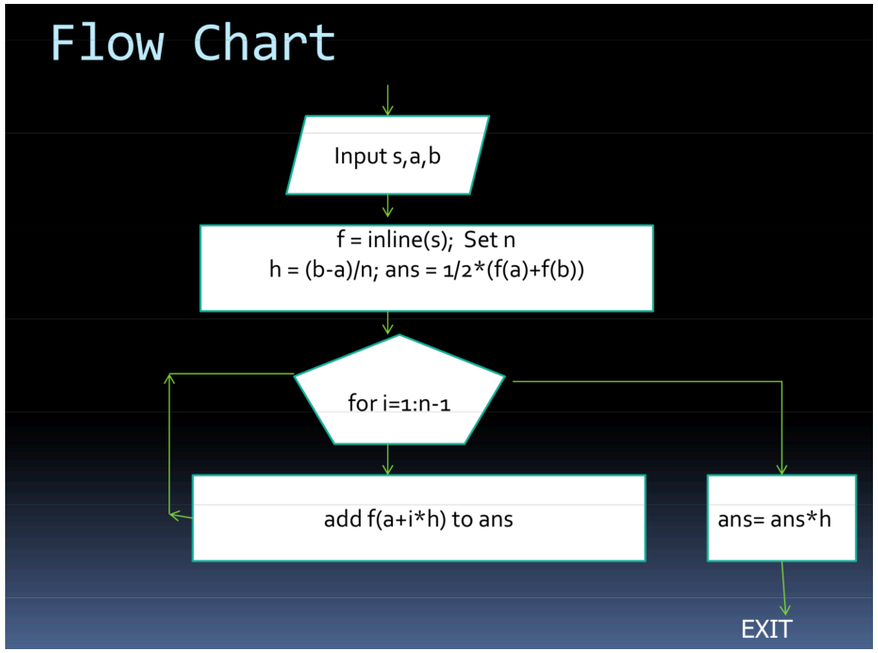
Flow Chart

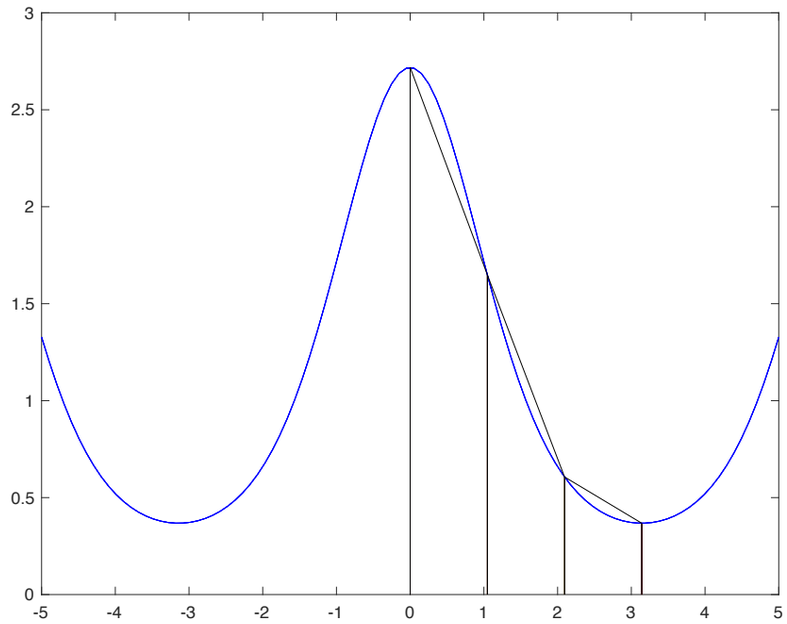

Input s,a,b
f = inline(s); Set n
h = (b-a)/n; ans = 1/2*(f(a)+f(b))
for i=1:n-1
add f(a+i*h) to ans
ans= ans*h
EXIT

```
% Implement the flow chart  of
% integration by composite
% Trapzoid rule
```

```
str = 'exp(cos(x))';
f = inline(str)
n = 4
b = pi; a = 0;
h = (b-a)/(n);
ans = 1/2*(                );
for i = 1 : n - 1
    ans = ans +            ;
end
ans = ans * h;
fprintf('%15.14f\n',ans)
```

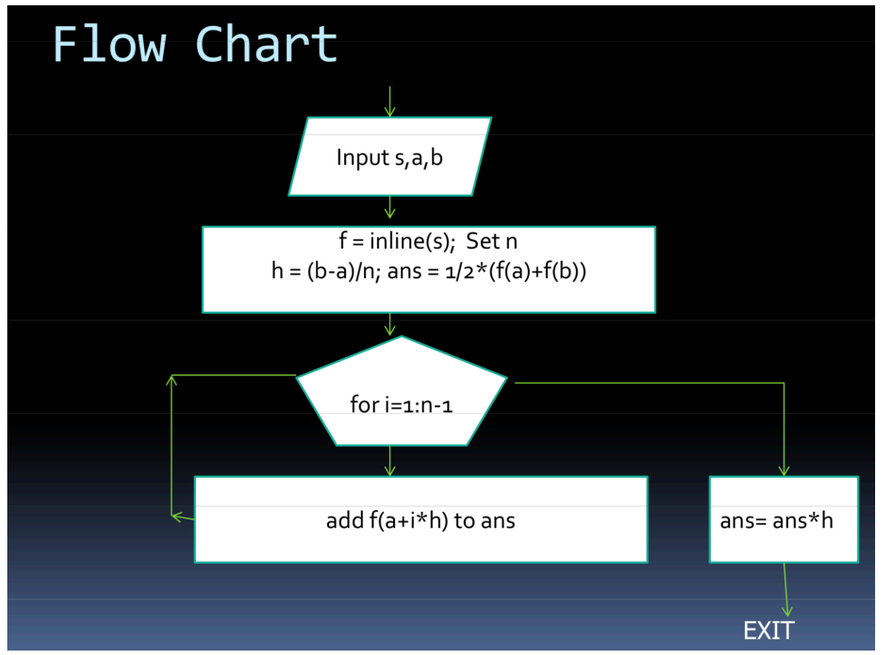
3.97746388635089





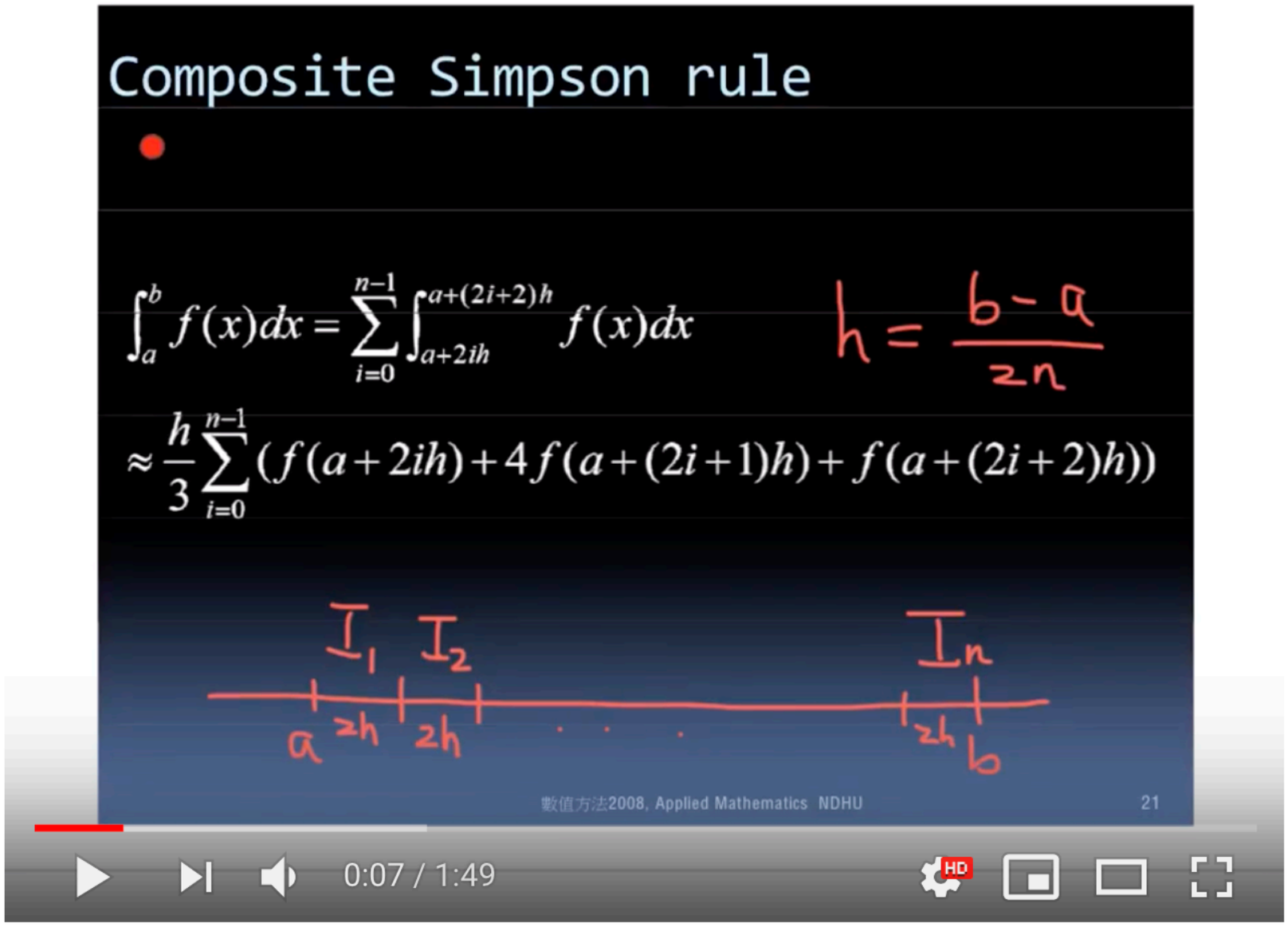
```
% Implement the flow chart  of
% integration by composite
% Trapzoid rule
```

```
str = 'exp(cos(x))';
f = inline(str)
n = 100
b = pi; a = 0;
h = (b-a)/(n);
ans = 1/2*(                );
for i = 1 : n - 1
    ans = ans +            ;
end
ans = ans * h;
fprintf('%15.14f\n',ans)
```



3.97746326050642

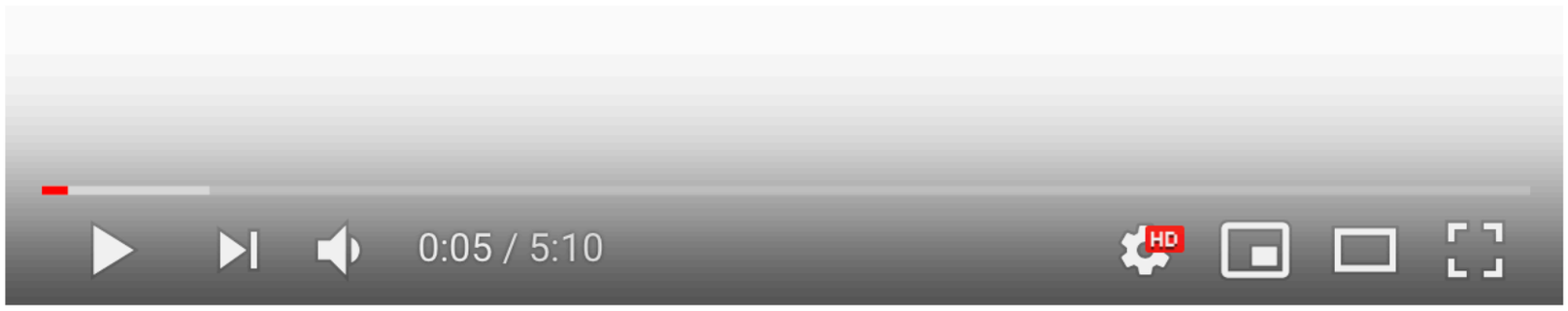
https://youtu.be/kkQnhRq31i0



State the composite Simpson rule

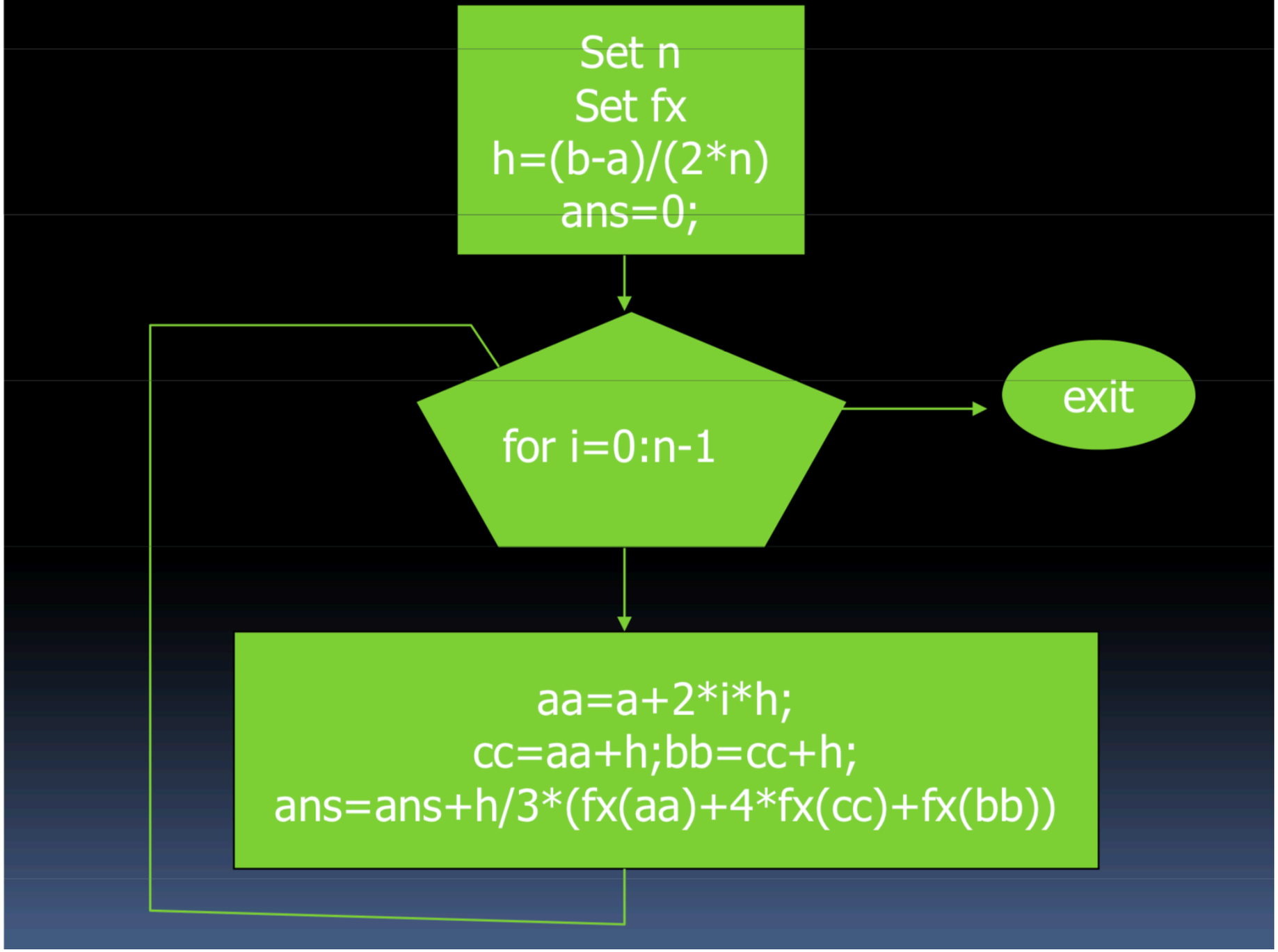
Problem 3. Derive the Simpson rule for numerical integration

$$\int_a^b f(x)\,dx \approx \frac{b-a}{6}\left[f(a)+4f\left(\frac{a+b}{2}\right)+f(b)\right]$$

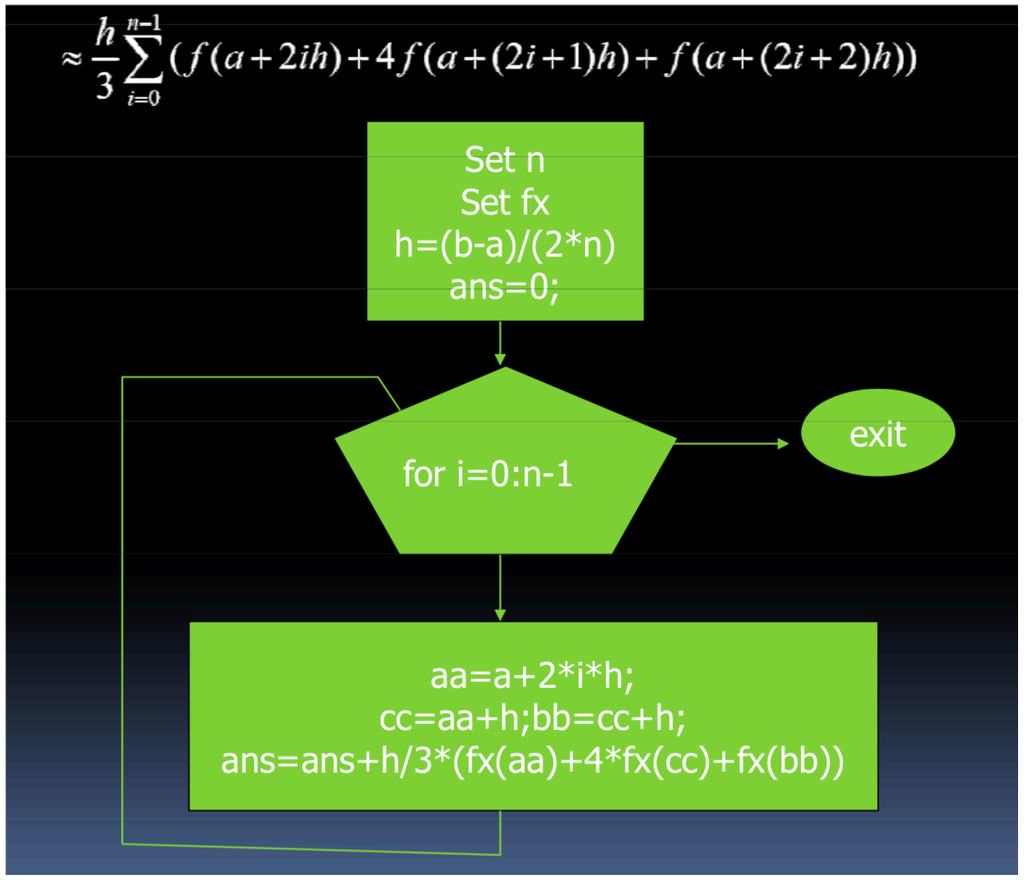


Deriving the Simpson rule

$$\approx \frac{h}{3}\sum_{i=0}^{n-1}(f(a+2ih)+4f(a+(2i+1)h)+f(a+(2i+2)h))$$

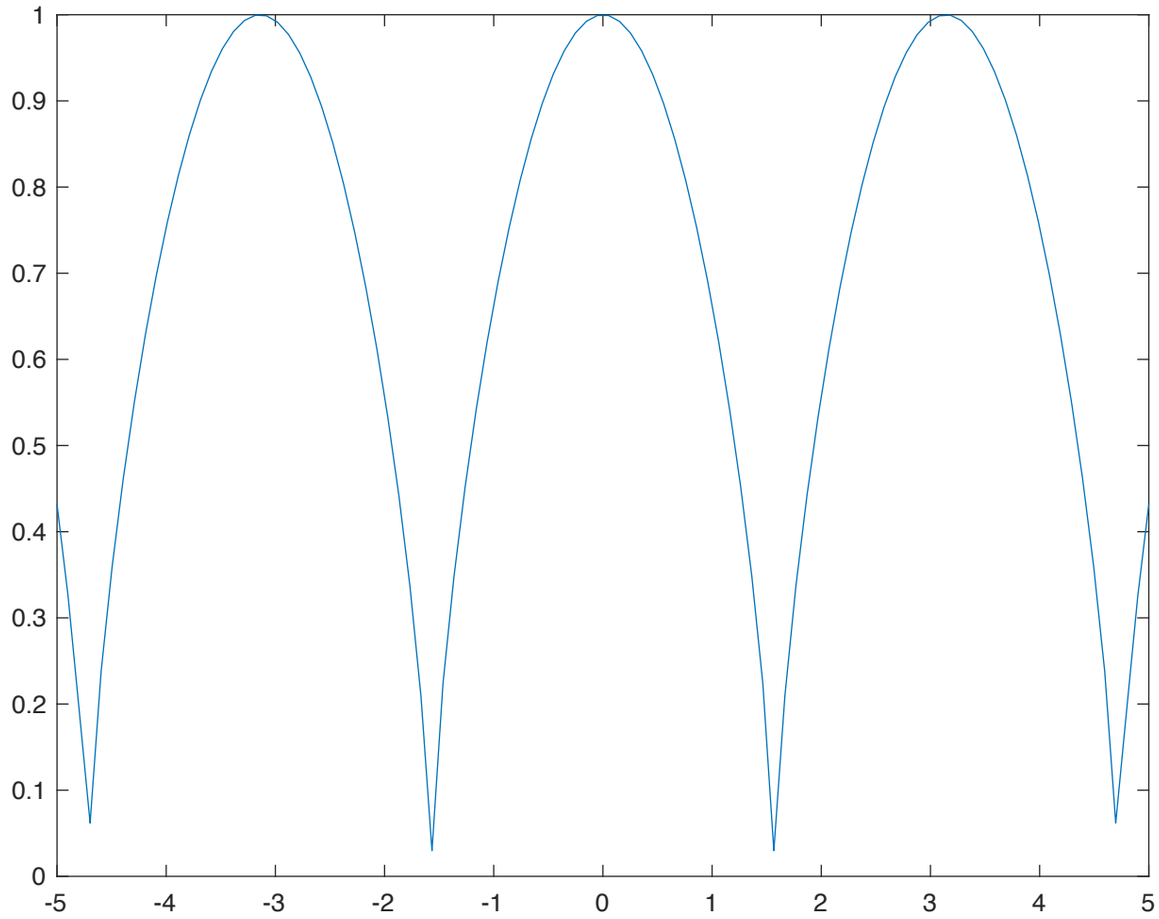


```
% Implement the flow chart  of
% integration by composite
% Simpson rule

str = 'exp(cos(x))';
f = inline(str)
n = 100
b = pi; a = 0;
h = (b-a)/(2*n);
ans = 0;
for i = 0 : n - 1
    aa = a +          ;
    cc = aa + h; bb = cc + h;
    ans = ans + h/3*(                          );
end
fprintf('%10.9f\n',ans)
```




```
     Inline function:
     f(x) = exp(cos(x))


n =

   100

3.977463261
```

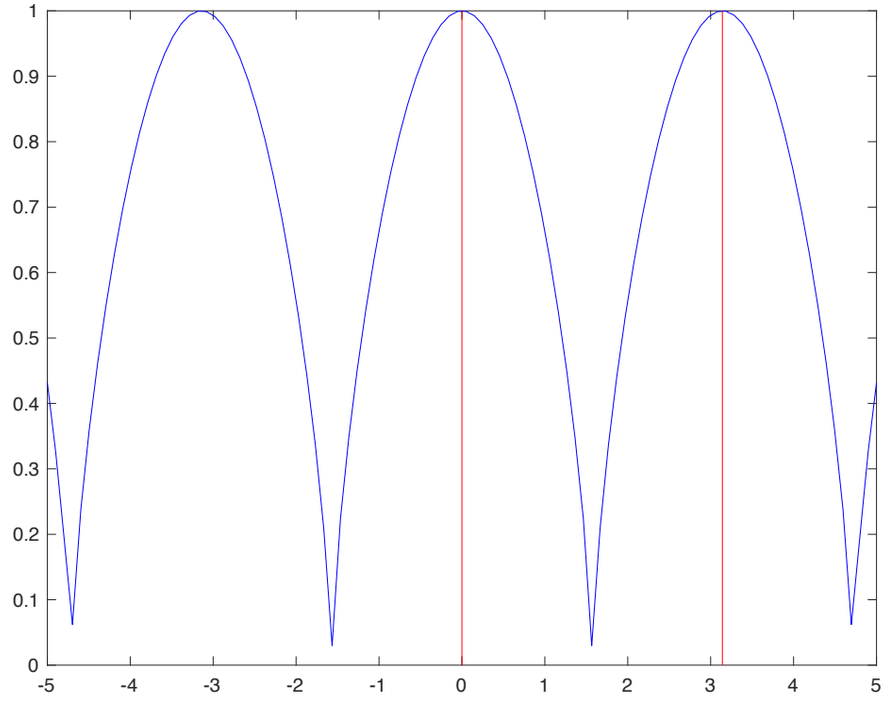
```
>> f = inline('(1-sin(x).^2).^(1/3)');
>> a = linspace(-5,5);
>> plot(a,f(a))
```



$$\int_0^{\pi} (1 - sin(x)^2)^{(1/3)} dx = ?$$

```
f = inline('                                    ');
a = linspace(-5,5);
plot(a,f(a),'b'); hold on
plot([0 0],[0 f(0)],'r');
plot([pi pi],[0 f(pi)],'r');

ans = integral(@(x) (1-sin(x).^2).^(1/3),      );
fprintf('%18.17f\n',ans);
```

2.24050266678531873

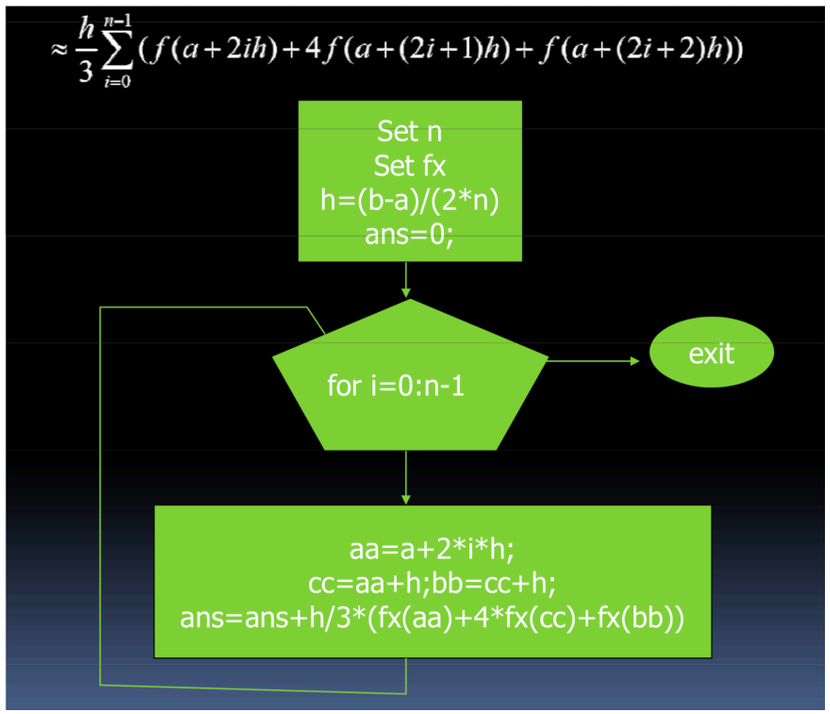


$$\int_0^{\pi} exp(cos(x))dx = ?$$

```
str = '(1-sin(x).^2).^(1/3)';
F= inline(int(str2sym(str)))
fprintf('%18.17f\n',                );
```

```
Warning: Indefinite Integral, using definite integral with
lower bound 0 and upper bound 'x'.

F =

     Inline function:
     F(x) = integral(@(x)(-sin(x).^2+1.0).^(1.0./3.0),0,x)

2.24050266678531873
```

```
% Implement the flow chart  of
% integration by composite
% Simpson rule

str = '(1-sin(x).^2).^(1/3)';
f = inline(str)
n = 100
b = pi; a = 0;
h = (b-a)/(2*n);
ans = 0;
for i = 0 : n - 1
    aa = a +          ;
    cc = aa + h; bb = cc + h;
    ans = ans + h/3*(                              );
end
fprintf('%10.9f\n',ans)
```



2.240418485