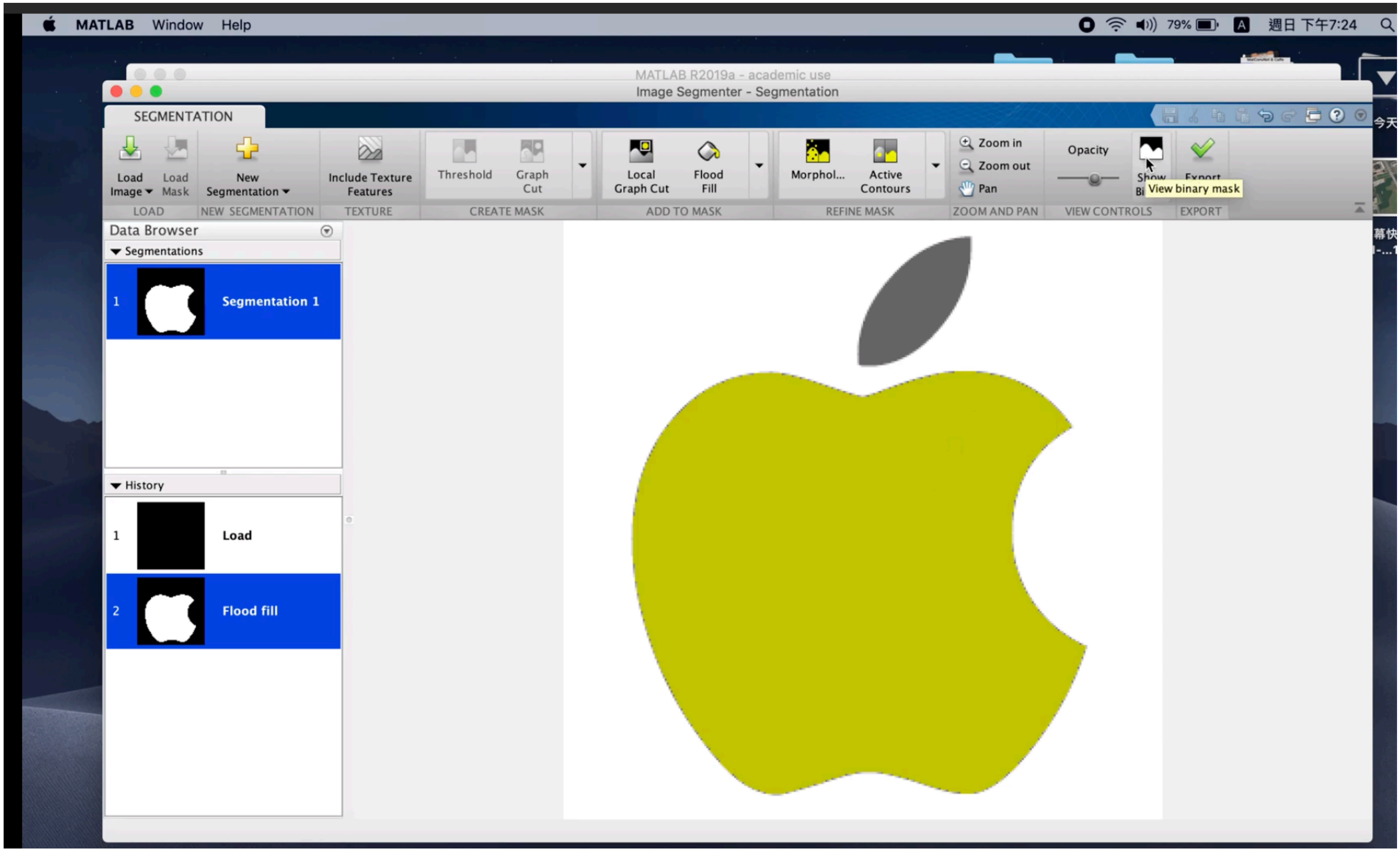
Numerical Integration


MATLAB Window Help
79%
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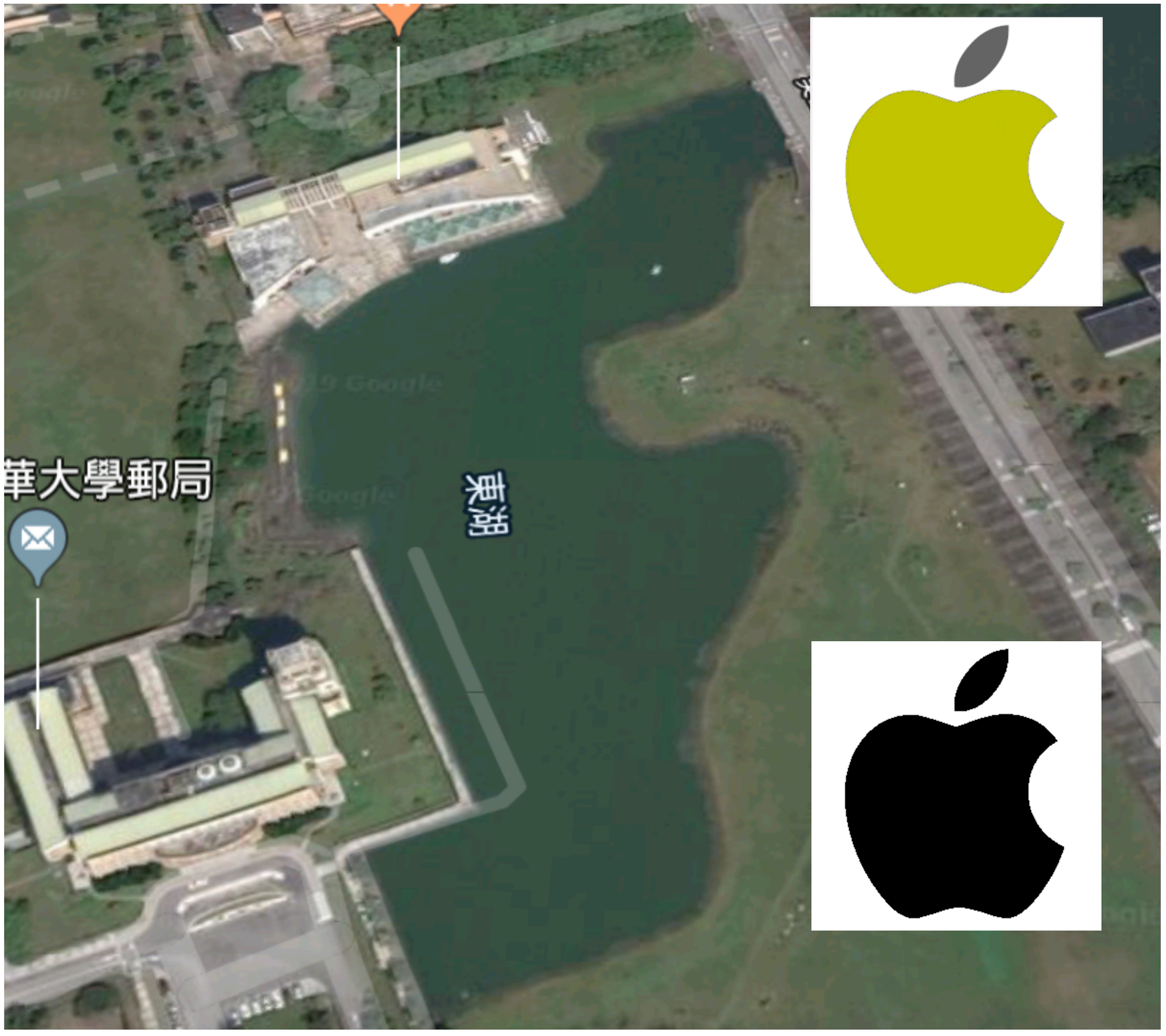
MATLAB R2019a - academic use
Image Segmenter - Segmentation
SEGMENTATION
Load Image
Load Mask
New Segmentation
Include Texture Features
Threshold
Graph Cut
Local Graph Cut
Flood Fill
Morphol...
Active Contours
Zoom in
Zoom out
Pan
Opacity
View binary mask
Export
LOAD
NEW SEGMENTATION
TEXTURE
CREATE MASK
ADD TO MASK
REFINE MASK
ZOOM AND PAN
VIEW CONTROLS
EXPORT
Data Browser
Segmentations
1
Segmentation 1
History
1
Load
2
Flood fill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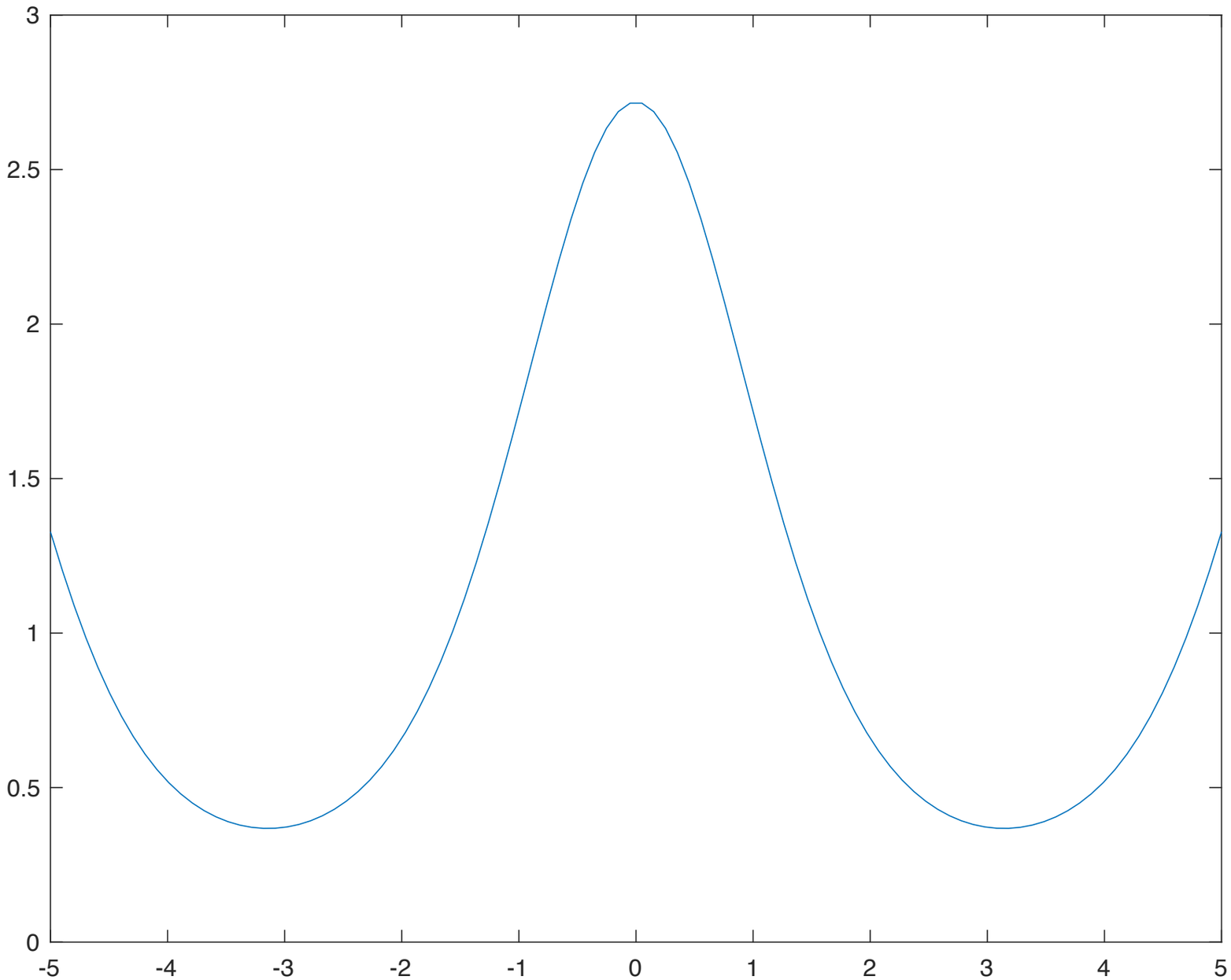
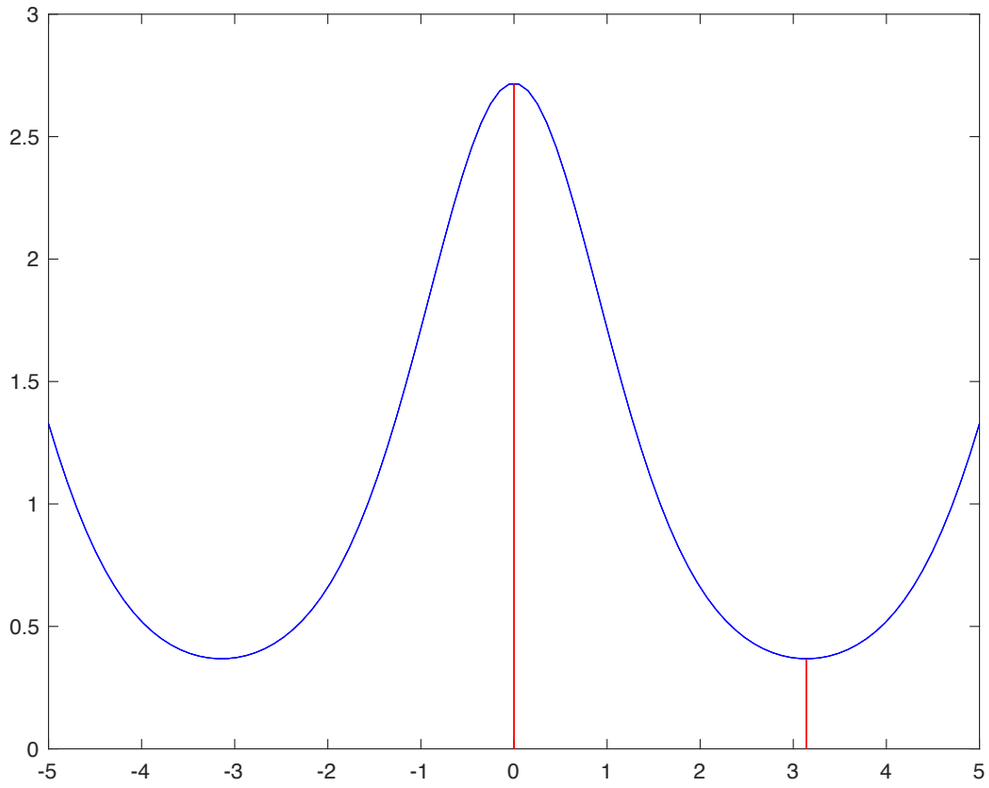
```
>> f = inline('exp(cos(x))');
>> z = linspace(-5,5);
>> plot(z,f(z))
```



```
% 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(                    ))
fprintf('%18.17f\n',                    );
```

```
3.97746326050642285
```

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

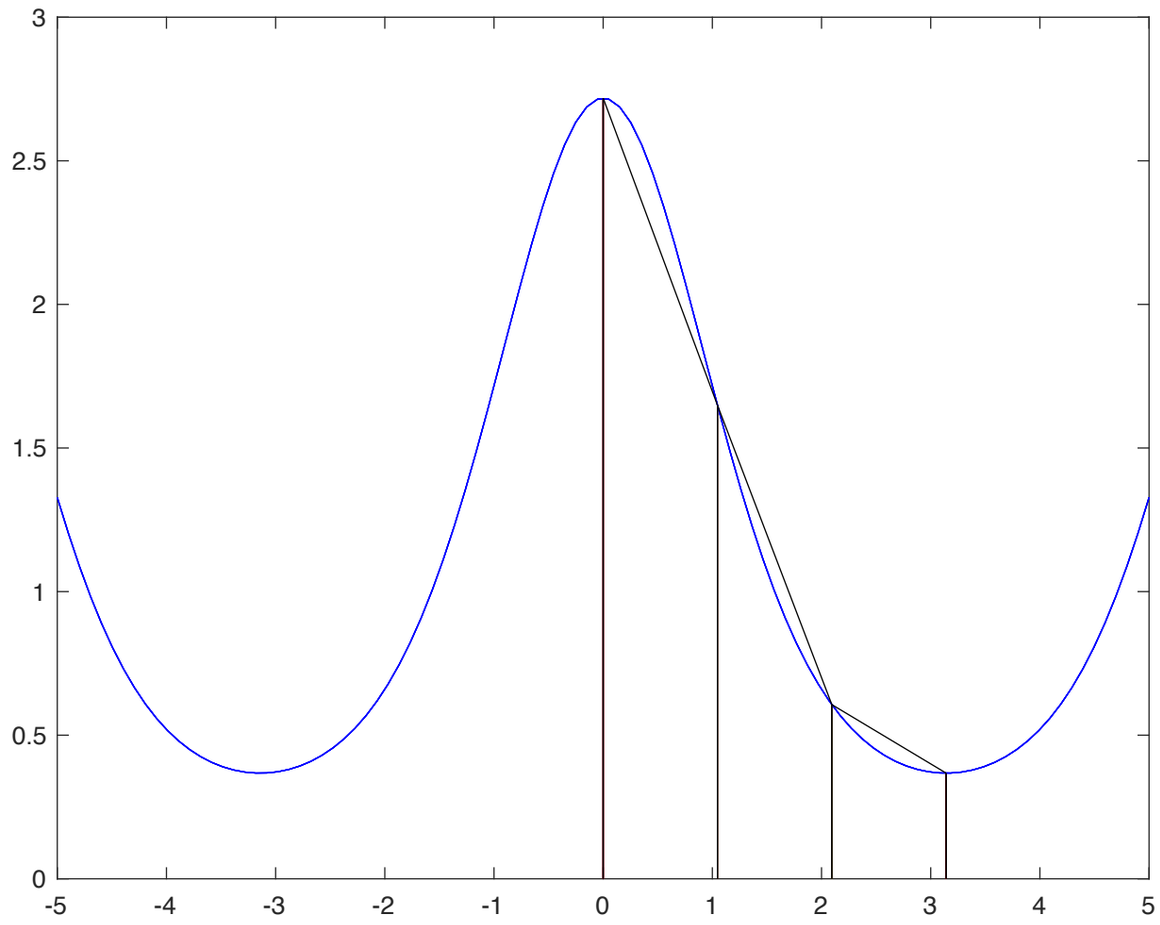
```
1 -    ans = integral(@(x)                    )
2 -    fprintf('%18.17f\n',ans);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
>> untitled2

ans =

    3.9775

3.97746326050642285
```

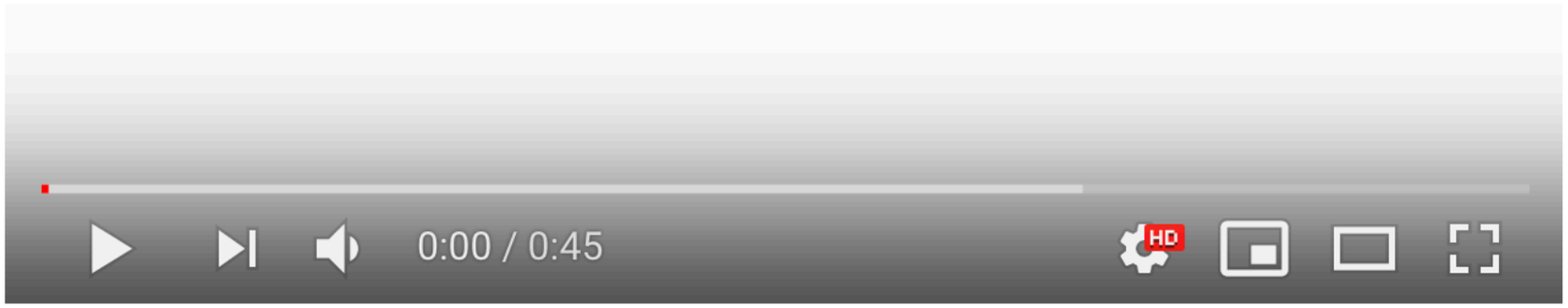
```
% partition the range [a, b] to a mesh of n knots
% Draw Trapezoids

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
```



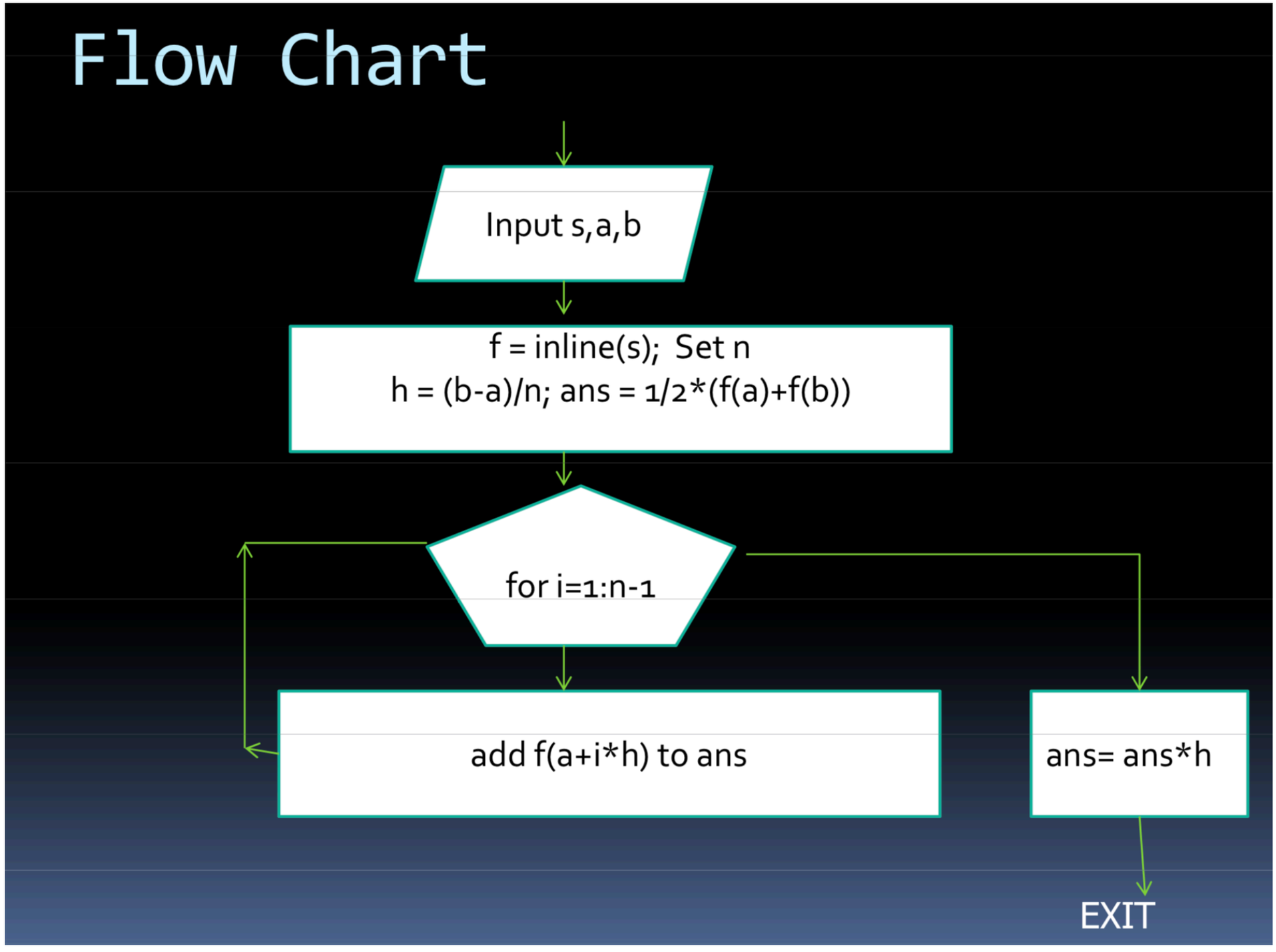
https://youtu.be/Y72JQu_JGxE

Problem 2. Implement the composite Trapezoid rule

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



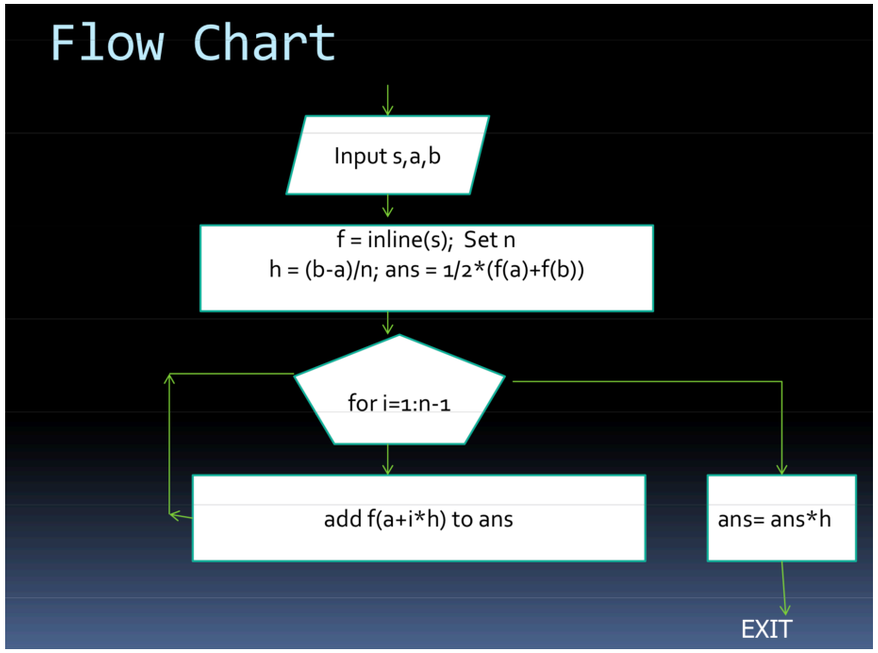
Flow Chart

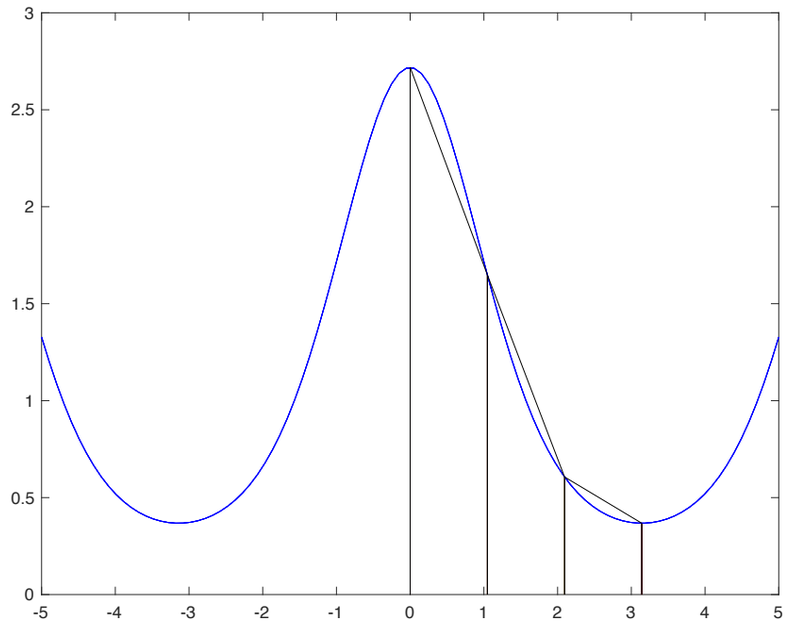

Input s,a,b
f = inline(s); Set n
h = (b-a)/n; ans = 1/2*(f(a)+f(b))
for i=1:n-1
add f(a+i*h) to ans
ans= ans*h
EXIT

```
% 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*(f(a)+f(b));
for i = 1 : n - 1
    ans = ans + f(a+i*h);
end
ans = ans * h;
fprintf('%15.14f\n',ans)
```

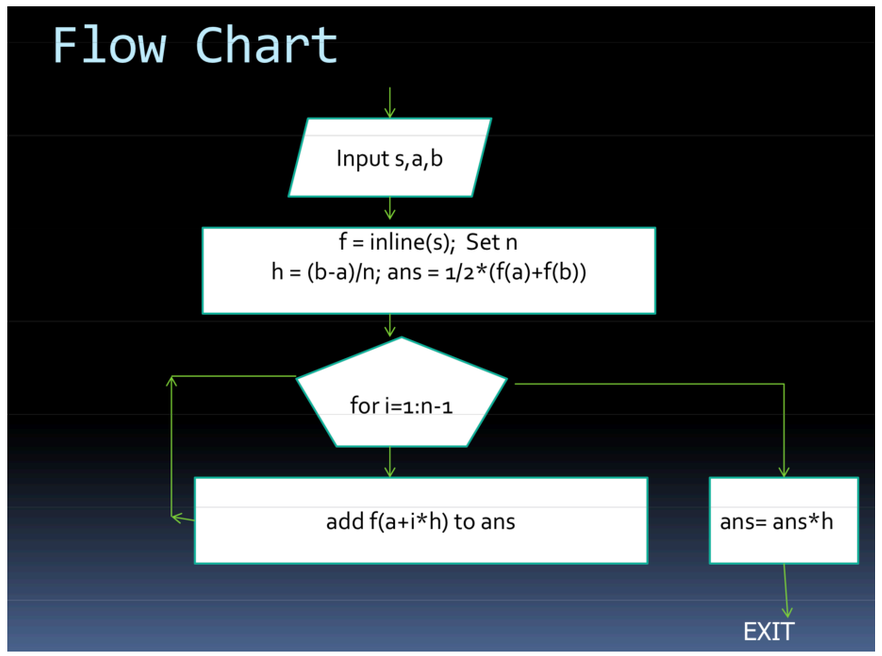
3.97746388635089





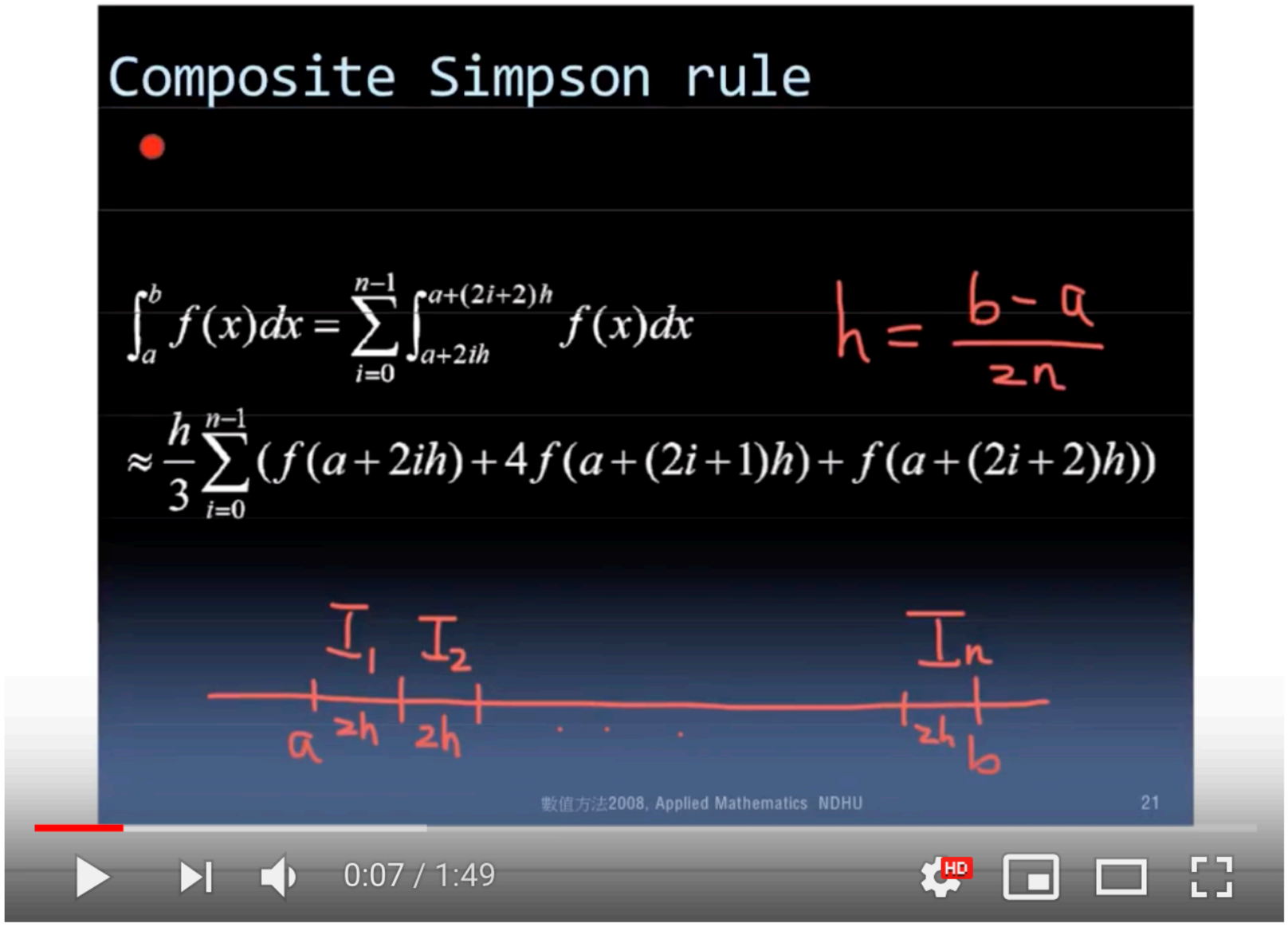
```
% Implement the flow chart  of
% integration by composite
% Trapzoid rule
```

```
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

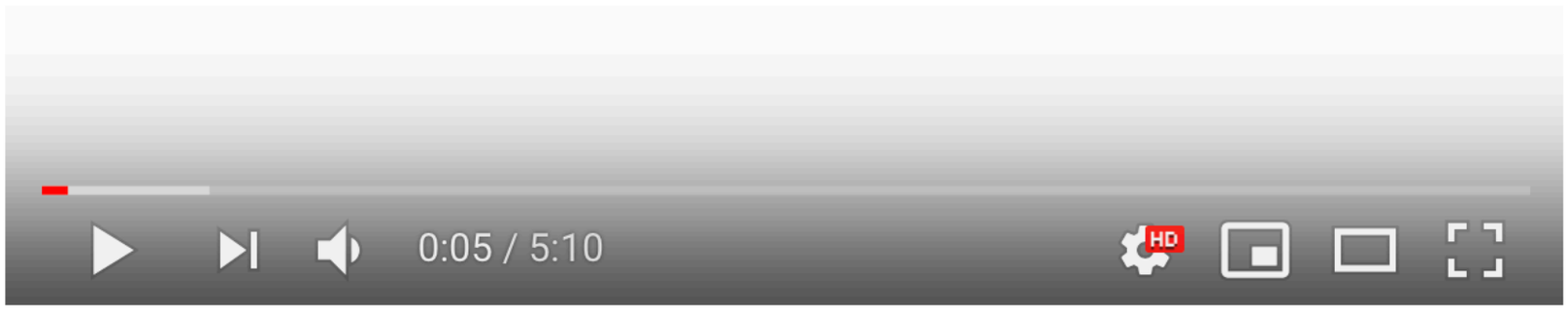
https://youtu.be/kkQnhRg31i0



State the composite Simpson rule

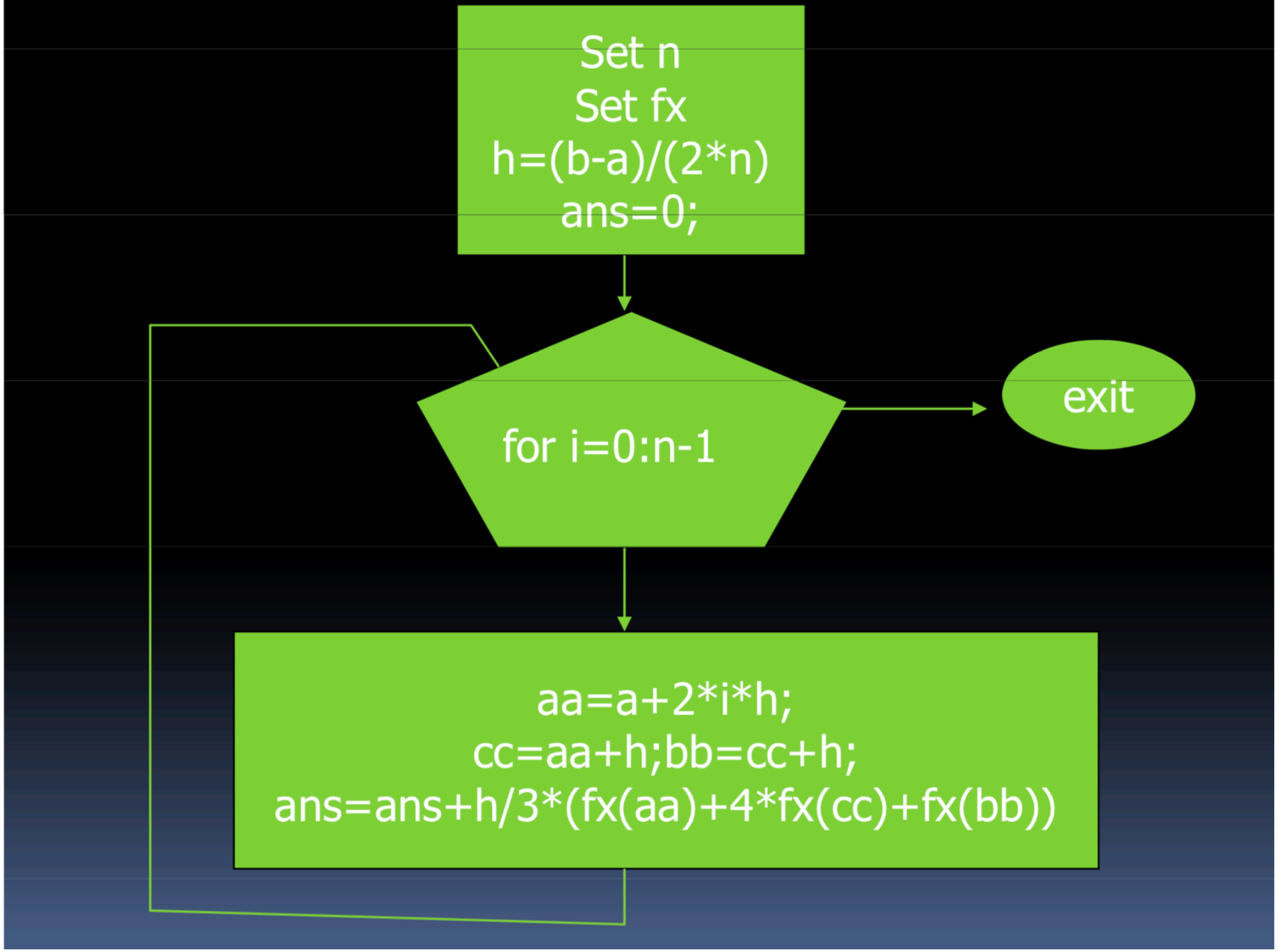
Problem 3. Derive the Simpson rule for numerical integration

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

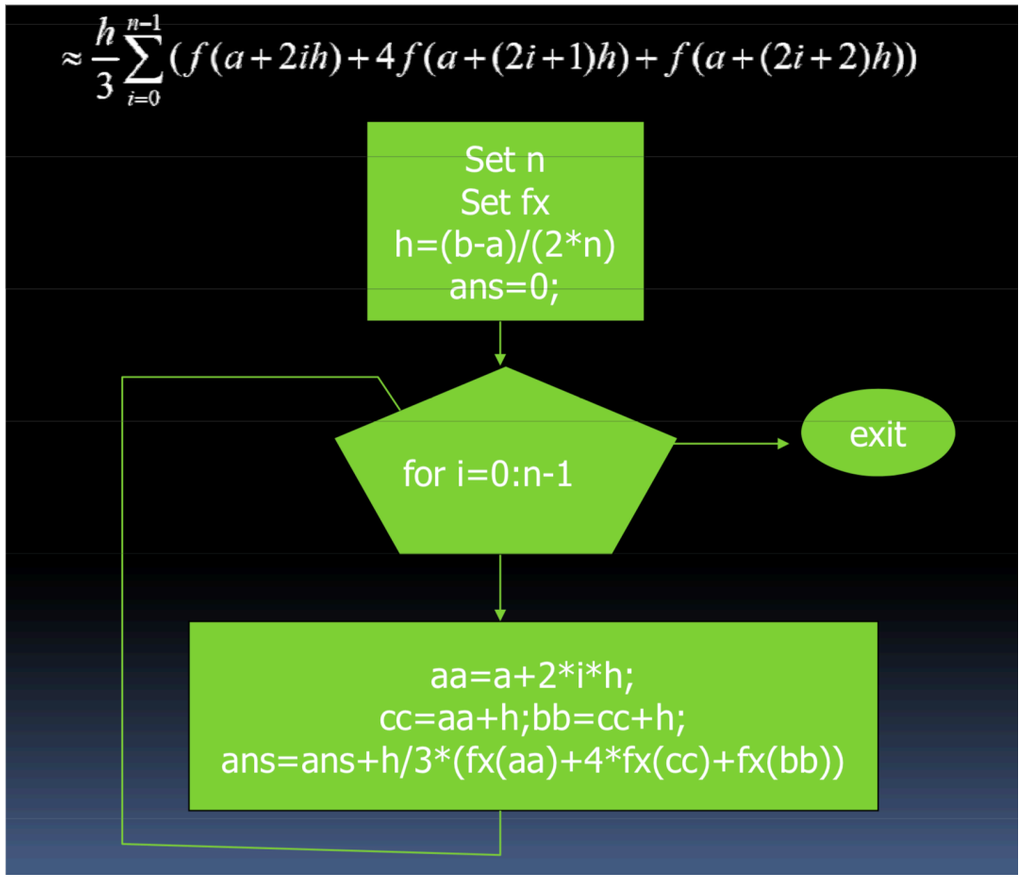


Deriving the Simpson rule

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

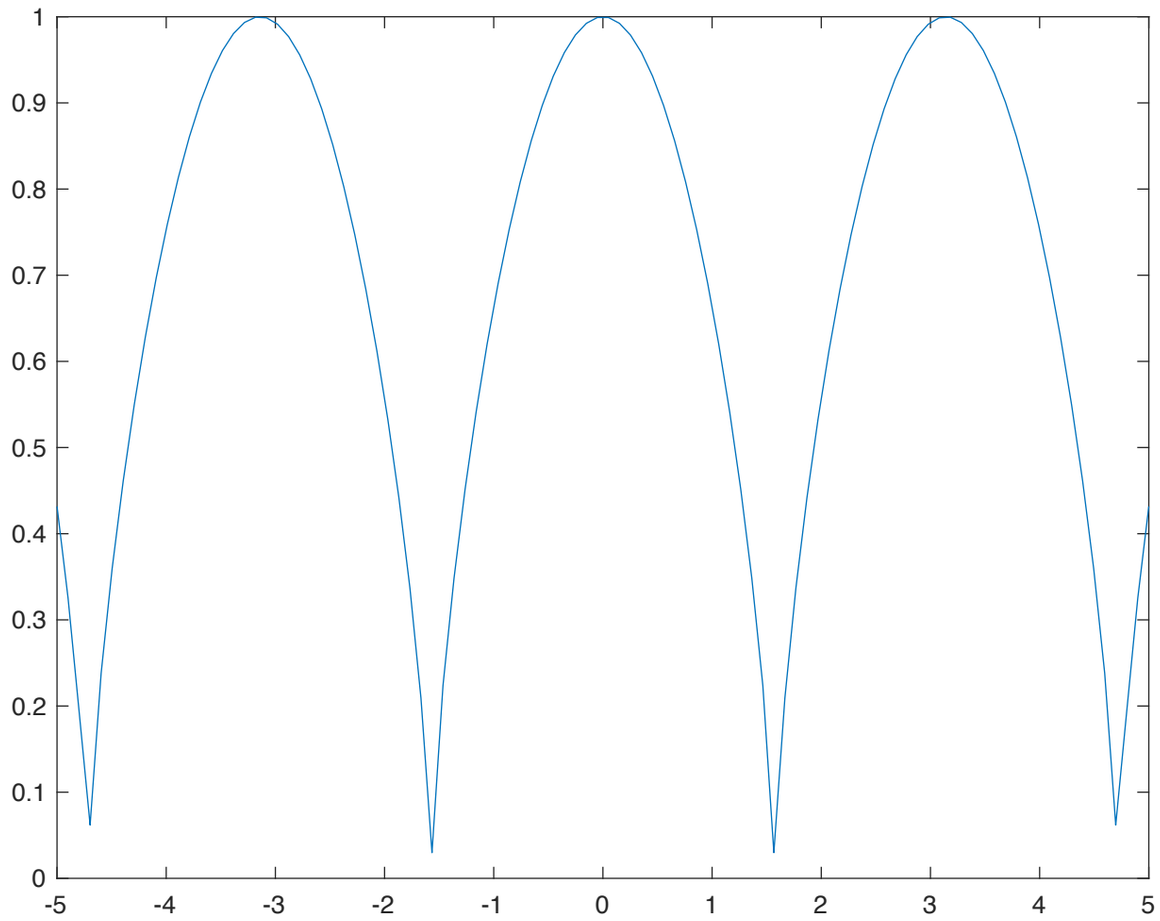


```
% Implement the flow chart  of
% integration by composite
% Simpson rule

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
```

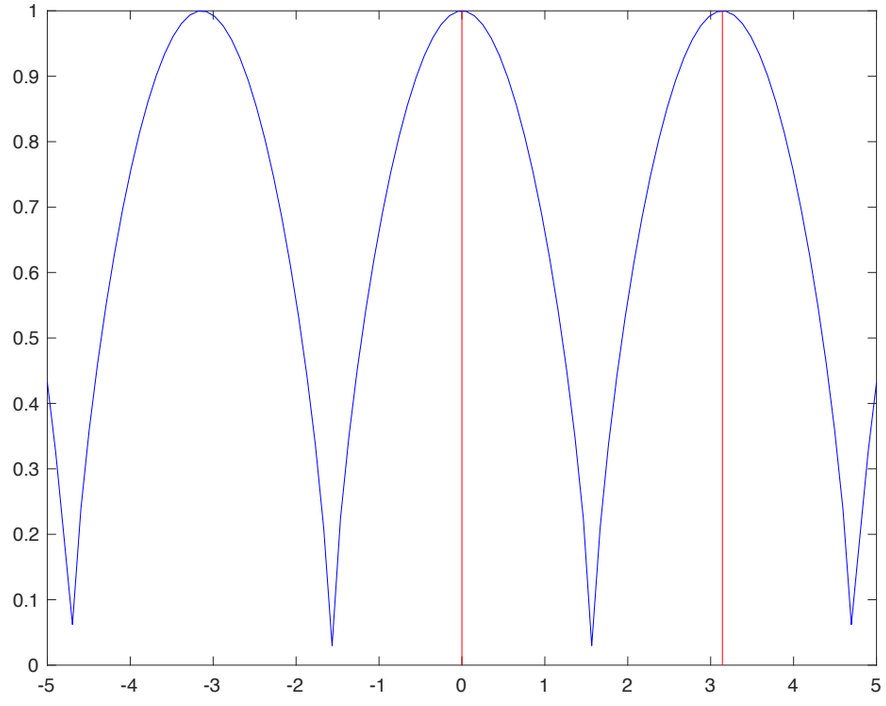
```
>> f = inline('(1-sin(x).^2).^(1/3)');
>> a = linspace(-5,5);
>> plot(a,f(a))
```



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

```
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

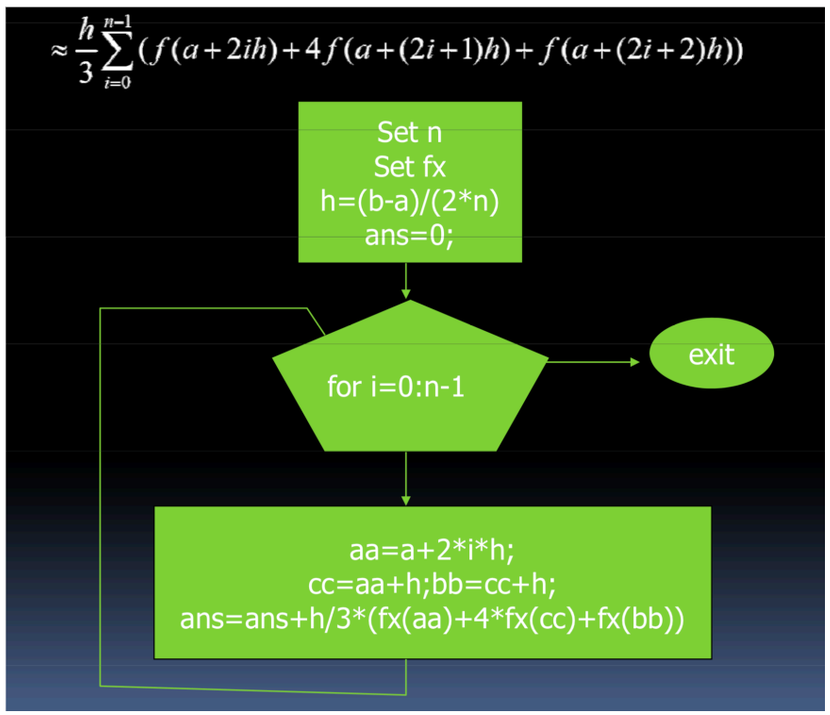


$$\int_0^{\pi} exp(cos(x))dx = ?$$

```
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