Ctrl + S

Numerical Integration

```
1 md"# Numerical Integration"
```

Load Packages

```
1 md"## Load Packages"
```

```
1 using QuadGK, ForwardDiff, Plots, PlutoUI
```

Define Function

```
1 md"## Define Function"
```

```
f (generic function with 1 method)
```

Assign Limits of Integration

$$[a, b]$$

```
xs = 0.0:0.01:4.0
```

```
ya = 0.0
```

```
yb = 2.0
```

```
dyda = Inf
```

```
dydb = 0.25
```

Evaluate Integrals

Area Under a Curve

$$A = \int_a^b f(x)\mathrm{d}x$$

"The integral from a to b of f of x, dx."

```
(5.33333, 5.68757e-8)
```

```
A = 5.33
```

Volume of a solid of revolution (around x-axis)

```
md"### Volume of a solid of revolution (around x-axis)"
```

$$V = \int_a^b \pi[f(x)]^2\mathrm{d}x$$

```
md"$V = \int_{a}^{b} \pi [f(x)]^2 \text{d}x$"
```

```
(25.1327, 0.0)
```

```
volume, volume_error = quadgk(x -> pi * f(x)^2, a, b)
```

```
circle3d (generic function with 1 method)
```

```
function circle3d(x, r)
theta = LinRange(0, 2pi, 360)
    fill(x, 360), r * cos.(theta), r * sin.(theta)
end
```

```
plotcircles! (generic function with 1 method)
```

```
function plotcircles!(p3d, a, b)
for x in LinRange(a, b, 20)
    plot!(p3d, circle3d(x, f(x)),
    linewidth = 2,
        color = :dodgerblue,
        alpha = 0.5
    )
    end
end
```

Arc Length

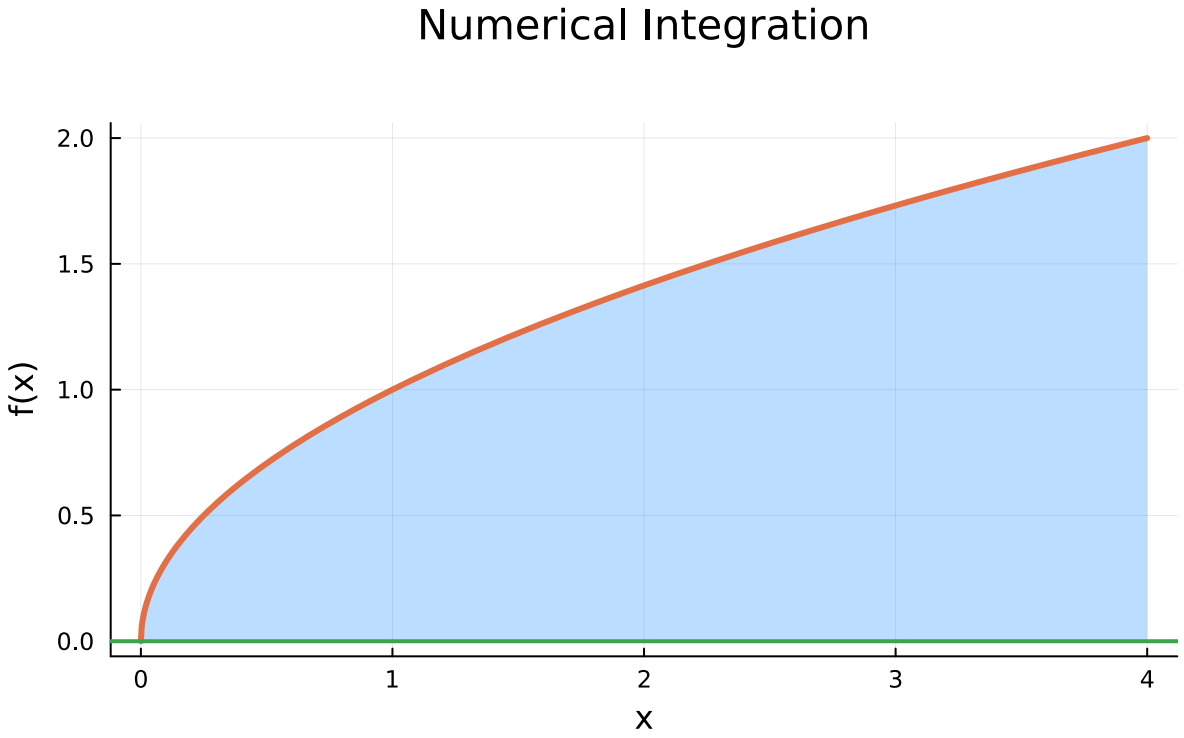
```
md"### Arc Length"
```

$$s = \int_a^b \sqrt{1 + \left(\frac{dy}{dx} \right)^2} \, \mathrm{d}x$$

```
md"$s = \int_{a}^{b} \sqrt{1 + \left( \frac{dy}{dx} \right)^2} \text{d}x$"
```

(4.64678, 6.71939e-8)

```
arc_length, arc_error = quadgk(
x -> sqrt(1 + ForwardDiff.derivative(f, x)^2),
    a, b
)
```




```
begin
    p2d = plot(xs, f.(xs),
    fill = true,
    fillcolor = :dodgerblue,
    fillalpha = 0.3
    )

    plot!(p2d, f,
    linewidth = 3,
    legend = false,
    title = "Numerical Integration",
    xaxis = "x",
    yaxis = "f(x)",
    formatter = :plain,
    widen = true,
        xlims = (0, 4),
    ylims = (0, 2),
    aspect_ratio = 1
    )

    hline!([0], linewidth = 2)
end
```

```
s = 4.65
```

```
s = round(arc_length, digits = 2)
```

Area of a Surface of Revolution (around x-axis)

```
md"### Area of a Surface of Revolution (around x-axis)"
```

$$S = \int_a^b 2\pi f(x) \sqrt{1 + \left(\frac{dy}{dx} \right)^2} \, \mathrm{d}x$$

```
md"$S = \int_{a}^{b} 2 \pi f(x) \sqrt{1 + \left( \frac{dy}{dx} \right)^2} \text{d}x$"
```

(36.1769, 4.89456e-8)

```
surface_area, surface_error = quadgk(
x -> 2 * pi * f(x) * sqrt(1 + ForwardDiff.derivative(f, x)^2),
    a, b
)
```

S = 36.18

```
S = round(surface_area, digits = 2)
```

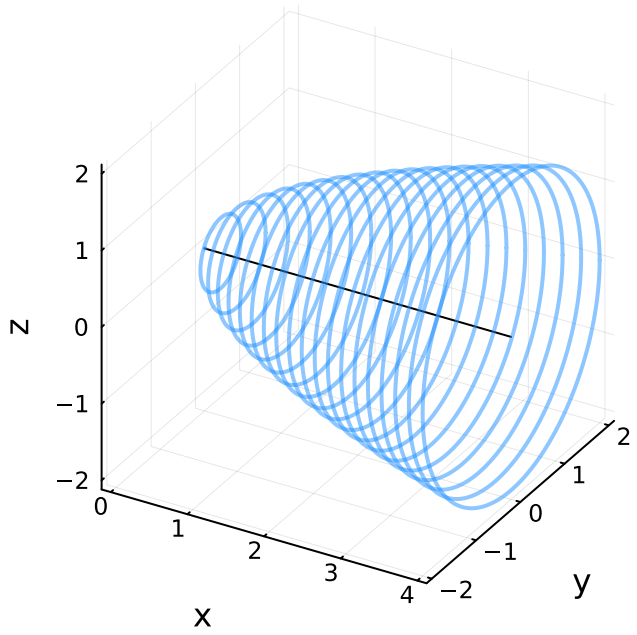
a: 0.0 | b: 4.0

```

md"""
a: $(@bind a Slider(0.0:0.01:4.0, 0.0, true)) |
b: $(@bind b Slider(0.0:0.01:4.0, 0.0, true))
"""
```

a: 0.0 | b: 4.0 | f(a): 0.0 | f(b) : 2.0 | f'(a): Inf | f'(b) : 0.25 \ Area: 5.33 | Arc Length: 4.65 | Surface Area (x-axis): 36.18

```
md"""
a: $(a) | b: $(b) | f(a): $(ya) | f(b) : $(yb) | f'(a): $(dyda) | f'(b) : $(dydb) \
Area: $(A) | Arc Length: $(s) | Surface Area (x-axis): $(S)
"""

```

Revolution Around X-Axis




```
begin
p3d = plot([0,4], [0,0], [0,0],
linewidth = 1,
    color = :black,
    legend = false,
    title = "Revolution Around X-Axis",
    xaxis = "x",
    yaxis = "y",
    zaxis = "z",
    formatter = :plain,
    widen = true,
    xlims = (0,4),
    ylims = (-2, 2),
    zlims = (-2, 2)
)
    plotcircles!(p3d, a, b)
    p3d
end
```