In [31]:
```julia
using Plots
```

In [33]:
```julia
N = 500
interval = (0, 2pi)
L = interval[2] - interval[1]

#Assign sub-intervals
x = range(interval[1], stop = interval[2], length = N);

#Define function (in this case, cos(x)) and evaluate it along discretized inte
rval
func = round.(cos.(x),digits=8)

#Check to see that the periodic condition holds
func[1] == func[length(func)] ? println("Periodic") : println("Non-Periodic")
```

```
Periodic
```

In [34]:
```julia
#Task One: Output Fourier coefficients

Δx = L/(N-1)
yhat = []

for j in 1:N
    sum = 0
    for m in 1:(N)
        iteration = exp((-2*im*j*pi/L)*x[m])*func[m]
        sum += iteration
    end
    append!(yhat, round.((Δx/L)*(sum - func[1]), digits=8))
end
```

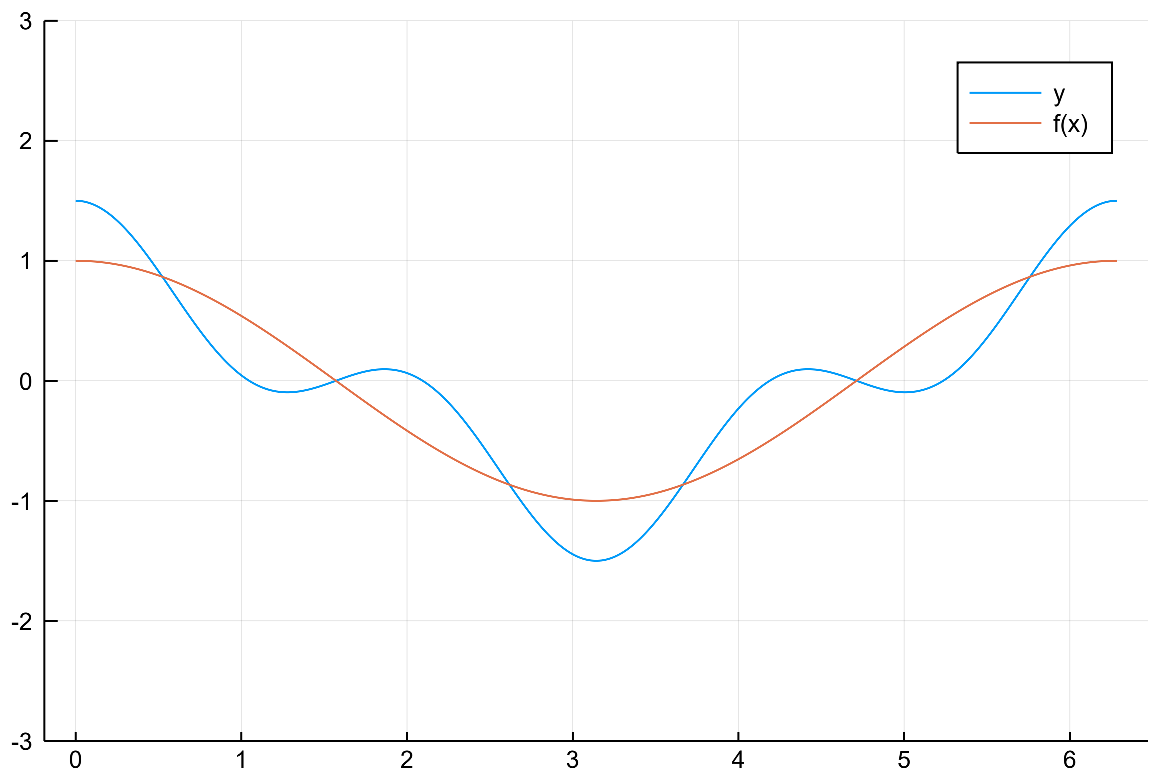
In [35]:
```julia
#Print non-zero (real or imaginary) coefficients and their index

for i in 1:length(yhat)
    if real(yhat[i]) != 0
        println("REAL --- Index: ", i, " Coefficient: ", real(yhat[i]))
    end

    if imag(yhat[i]) != 0
        println("Imaginary --- Index: ", i, " Coefficient: ", imag(yhat[i]))
    end
end
```

```
REAL --- Index: 1 Coefficient: 0.5
REAL --- Index: 498 Coefficient: 0.5
REAL --- Index: 500 Coefficient: 0.5
```

In [37]:

```
#Task Two: Convert Fourier coefficients into approximate y values

z = []

for i in 1:N
    if i < (N-i+1)
        #Convert from cn to an and bn and evaluate cos(nk) and sin(nk) at each 
sub-interval
        append!(z,[((real(yhat[i]))+(real(yhat[N-i + 1])))*cos.((2*pi*i*x)/L)+
((imag(yhat[i]))+(imag(yhat[N-i + 1])))*sin.((2*pi*i*x)/L)])
    end

    #Include c0 conversion
    if N % 2 == 1
        if i === (N-i+1)
            a0 = fill(real(yhat[Int((N+1)/2)]),length(x))
            append!(z,[a0])
        end
    end
end

#Sum N Fourier terms evaluated at each sub-interval
y = sum(z)

plot(x,y, ylim=(-3,3), label="y")
plot!(x,func, label="f(x)")
```

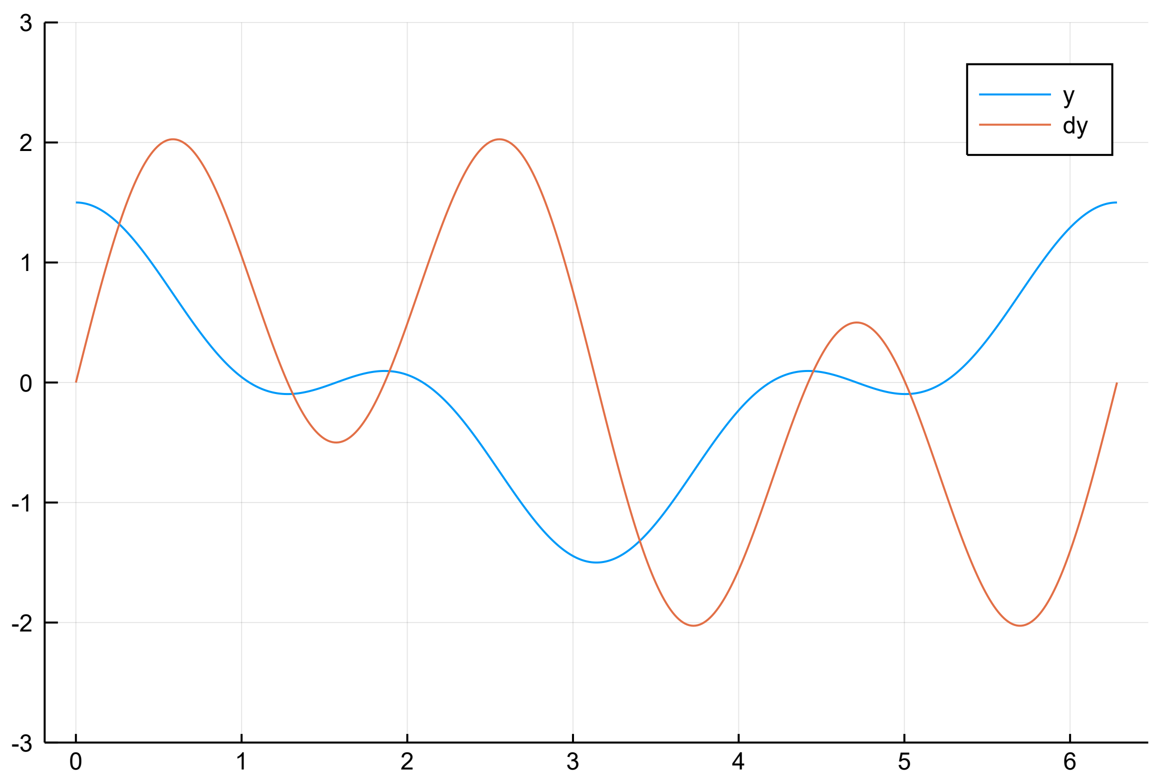
Out[37]:



In [38]:

```
#Task Three: Obtain derivative of approximated function

q = []

#Multiply imaginary term through ŷ such that we can perform the same conversio
n done in the last cell, but now on iŷ
iyhat = im*yhat

for j in 1:N
    if j < (N-j+1)
        append!(q,[((2*pi*j)/L)*(((real(iyhat[j]))+(real(iyhat[N-j + 1])))*cos
.((2*pi*j*x)/L)+((imag(iyhat[j]))+(imag(iyhat[N-j + 1])))*sin.((2*pi*j*x)/L
))])
    end
end

dy = sum(q)

plot(x,y,ylim=(-3,3), label="y")
plot!(x,dy, label="dy")
```

Out[38]:



In [39]:

```
#Print non-zero (real or imaginary) coefficients and their index

for i in 1:length(iyhat)
    if real(iyhat[i]) != 0
        println("REAL --- Index: ", i, " Coefficient: ", real(iyhat[i]))
    end

    if imag(iyhat[i]) != 0
        println("Imaginary --- Index: ", i, " Coefficient: ", imag(iyhat[i]))
    end
end
```

```
Imaginary --- Index: 1 Coefficient: 0.5
Imaginary --- Index: 498 Coefficient: 0.5
Imaginary --- Index: 500 Coefficient: 0.5
```