HW 5 Part 2

April 17, 2020

Files to include in Appendix: BackwardEuler.jl Adams*Bashforth2.jl GL*RK.jl

First I need to solve the ODE and put it into first order form

```
using Plots
using SymPy
@vars p q theta t

Ham = p^2/2 +cos(q)
```

$$\frac{p^2}{2} + \cos(q)$$

I need find the nondimentional momentum of the angle

```
thetadot = diff(Ham,p)
pdot = -diff(Ham,q) |> subs(q=>theta)
```

$$\sin(\theta)$$

therefore $thetaddot = sin(theta)$

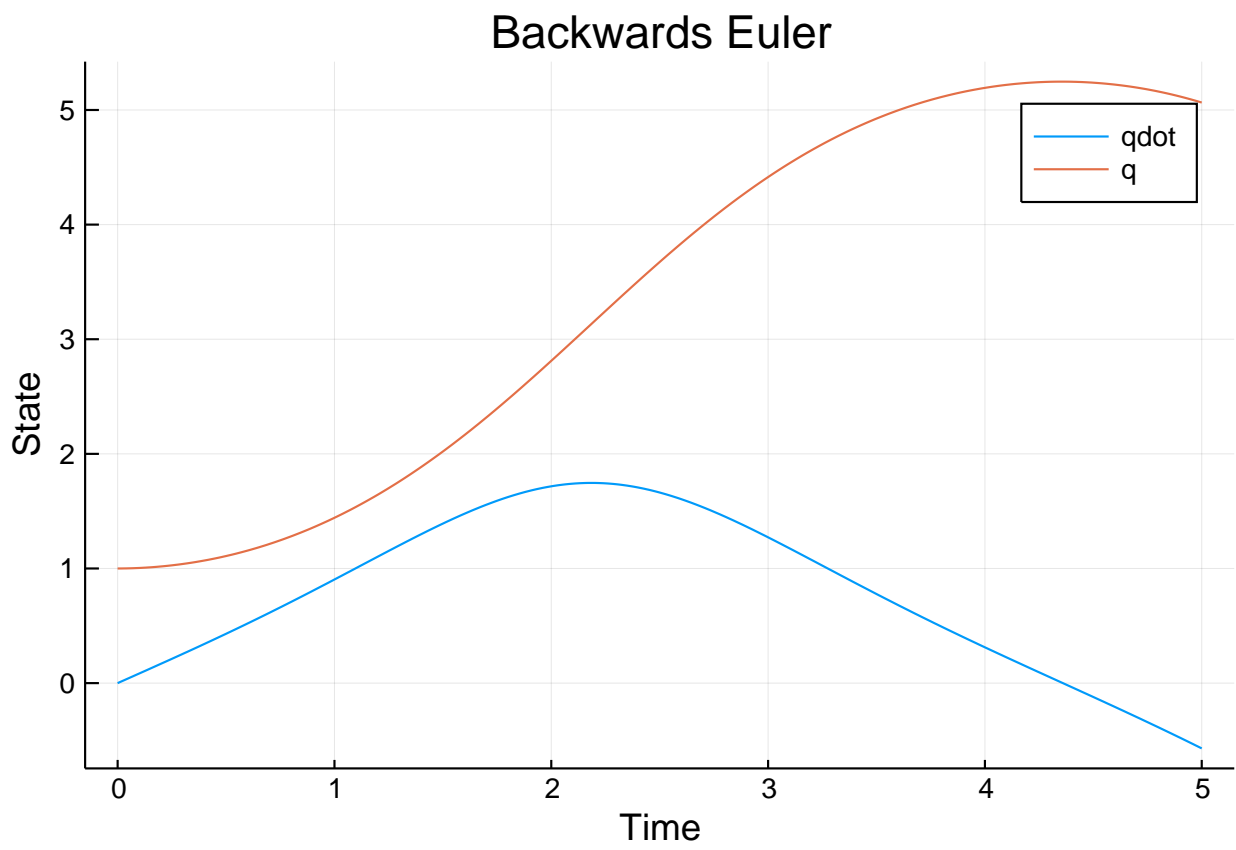we need to get it in first order form thetaddot = x1dot thetadot = x2dot

Now, there are two first order ODEs to solve.

1. $x1dot = sin(x2)$

2. $x2dot = x1$

Now to solve them

```
# Define givens
f(x) = [sin(x[2]) x[1]]
h = .01
x0 = [0 1.]
tf = 5;

include("BackwardEuler.jl")
x,t = BackwardEuler.beuler(f,tf,h,x0)
plot(t,x[:,1],label = "qdot")
    plot!(t,x[:,2],label = "q")
    xlabel!("Time")
    ylabel!("State")
    title!("Backwards Euler")
```

Backwards Euler


```julia
include("Adams_Bashforth2.jl")
x,t = Adams_Bashforth2.ab2(f,tf,h,x0)
plot(t,x[:,1],label = "qdot")
    plot!(t,x[:,2],label = "q")
    xlabel!("Time")
    ylabel!("State")
    title!("Adams Bashforth")
```

Adams Bashforth
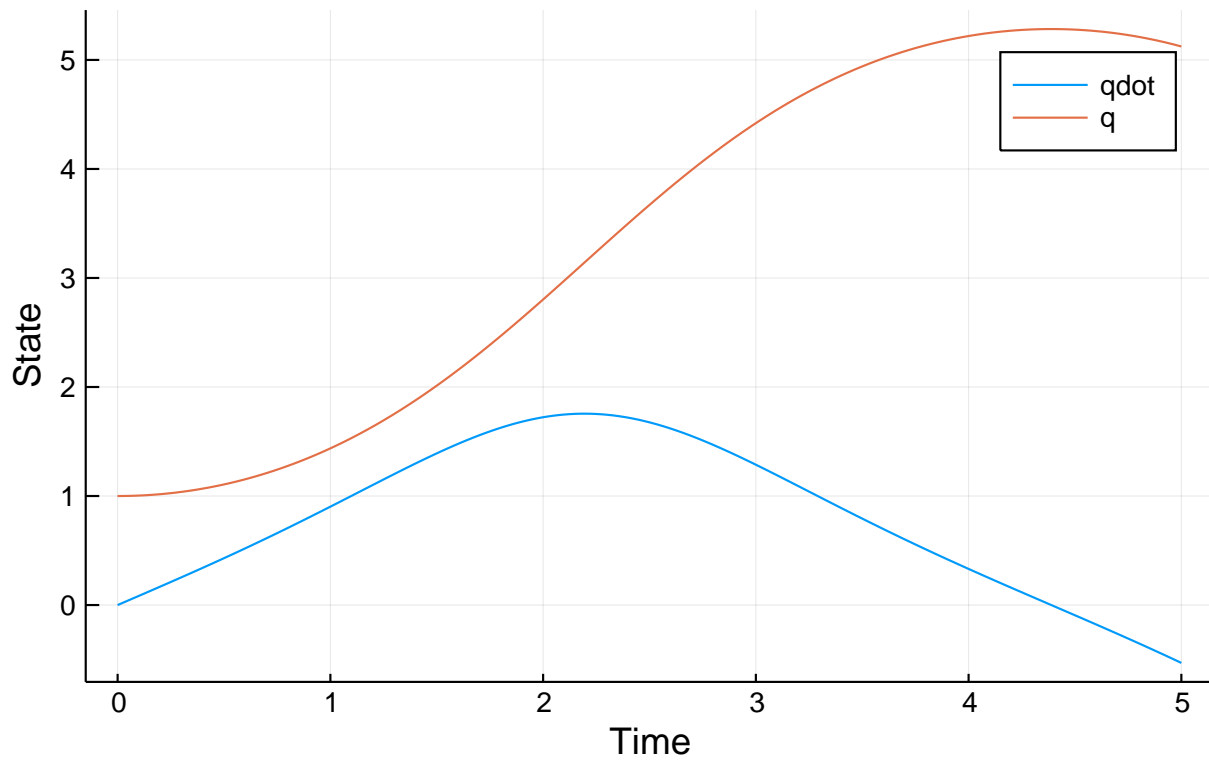

```julia
include("GL_RK.jl")
x,t = GL_RK.gl_rk(f,tf,h,x0)
plot(t,x[:,1],label = "qdot")
    plot!(t,x[:,2],label = "q")
    xlabel!("Time")
    ylabel!("State")
    title!("Gauss Legendre Runge Kutta")
```

Gauss Legendre Runge Kutta