MECH 230 Dynamics
Homework 2

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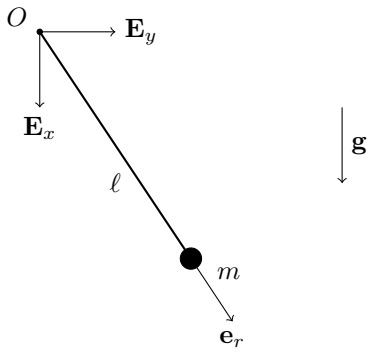
Due Wednesday September 11, 2024

In class, we found the equation of motion for a nonlinear pendulum of mass m suspended by a massless inextensible string of length ℓ to be

$$\ddot{\theta} + \frac{g}{\ell}\sin(\theta) = 0. \tag{1}$$

The tension in the string was also found to be

$$\mathbf{T} = -m\left(\ell\dot{\theta}^2 + g\cos(\theta)\right)\mathbf{e}_R. \tag{2}$$



1. Consider a pendulum of length $\ell = 1$ m, mass $m = 1$ kg released from rest with $\theta(t = 0) = \frac{\pi}{3}$ rad.

   Following the same steps as HW1, define `y = [y(1); y(2)]` where `y(1)` represents $\theta(t)$ and `y(2)` represents $\dot{\theta}(t)$ and use `ode45` to solve for the motion of the pendulum, ie. to solve for $\theta(t)$ and $\dot{\theta}(t)$.

   You can also read Matlab's ode45 documentation for guidance.

2. Plot the magnitude of the tension as a function of time.

3. The following function uses your results to animate the motion of the pendulum. Insert this function to the end of your code.

```
function animate_pendulum(t,y,l)

x = l*cos(y(:,1));
y = l*sin(y(:,1));

v = VideoWriter('pendulum_animation.avi');
open(v);
figure()
axis equal
axis(l*[-1 1 -1.5 0.5])
hold on
box on
for i = 1:length(t)
    mass = plot(y(i),-x(i),'o','linewidth',2,'color','k');
    string = plot([0 y(i)],[0 -x(i)],'linewidth',1,'color','k');
    frame = getframe(gcf);
    writeVideo(v,frame);
    pause(0.01)
    delete(mass)
    delete(string)
end
close(v);
end
```

Call your function using the following command to see and save the animation.

```
animate_pendulum(t,y,l)
```

Insert this command just after your `ode45` function call. Here, `t` is your time array, `y` is the solution array containing $\theta(t)$ and $\dot{\theta}(t)$ and `l` is the length of the string.

Deliverables: Please provide a hard copy of your code and a hard copy of the figure you generate in part 2.