RBE 502 Homework 1

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Contents

Problem 1

```
syms m l0 l theta k t;
```

Question 1

Assuming l0 is unextended length of string, and l is the extended length from l0:

```
g = 9.81; % m/s

% Calculate Kinetic Energy:
KE = 1/2*m*diff(l, t)^2 + 1/2*m*(l0 + l)^2 *diff(theta, t)^2;

% Calculate Potential Energy:
Pspring = 1/2*k*l^2;
Pgrav = m*g*(l0+l)*(1-cos(theta))-m*g*l;

L = KE - Pspring - Pgrav
```

```
L =

(981*l*m)/100 - (k*l^2)/2 + (981*m*(cos(theta) - 1)*(l + l0))/100
```

```
eq1 = diff(diff(L, diff(l,t)), t) - diff(L, l) == 0;
eq2 = diff(diff(L, diff(theta, t)), t) - diff(L, theta) == 0;


l_dotdot = (l+r)*diff(theta, t)
```

```
l_dotdot =
```

```
0
```

Question 2: State Space Equation

```
stateSpaceEq1 =[diff(l, t);
                (l0+l)*diff(theta, t)^2 + g * cos(theta) - (k/m)*l;
                diff(theta, t);
                2/(l0+l) * diff(l, t) - g/(l0+l) * sin(theta)];
```

Question 3: Equilibrium of system

Equilibrium will be at:

l = (m * g) / k

theta = 0

Question 4

The equilibrium is stable, since the differential equations will approach 0 over time

Problem 2

```
syms x(t);
```

Question 1: State Space Form

```
x_m = [x; diff(x,t)]
x_dot_m = [x_m(2); 5*x_m(2)-10*x]
```

```
x_m(t) =

          x(t)
 diff(x(t), t)


x_dot_m(t) =

                                        x(2)
             subs(diff(x(t), t), t, 2)
                              5*x(2) - 10*x(t)
 5*subs(diff(x(t), t), t, 2) - 10*x(t)
```

Question 2: Determine the equilibrium

The equilibrium point of this system is 0, as demonstrated below

```
ode1 = diff(x,t) == x;
ode2 = diff(x,t) == 5*diff(x,t)-10*x;

eq1 = dsolve(ode1, x(0) == 0)
eq2 = dsolve(ode2, x(0) == 0)
```

```
eq1 =

0


eq2 =

0
```

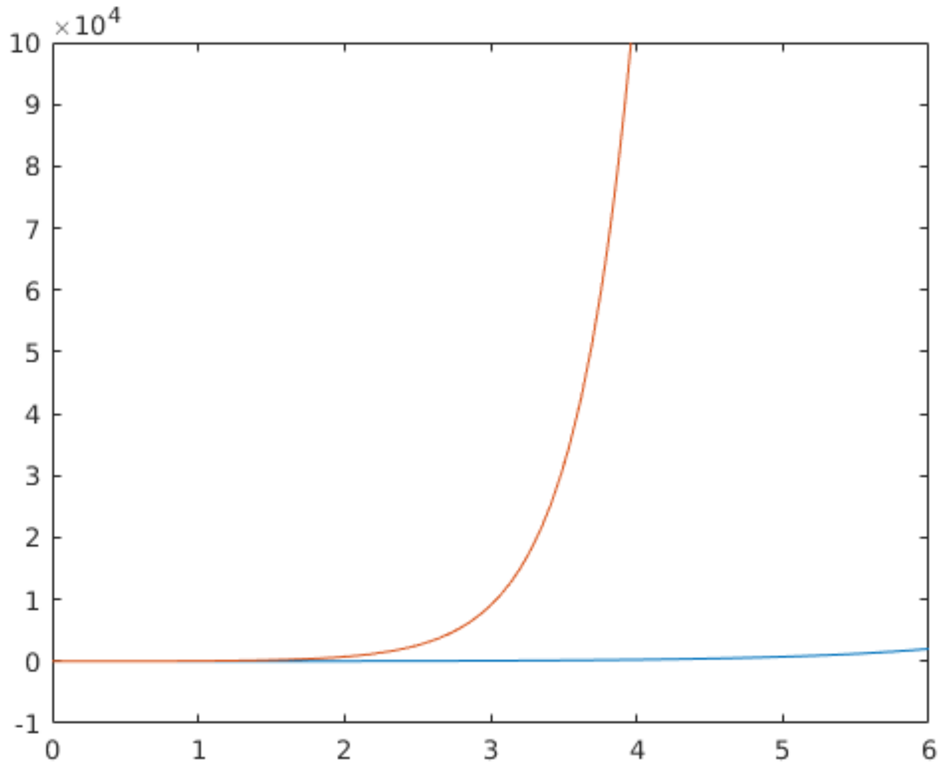
Question 3

As seen on the graph below, the system is unstable, because both curves separate from the equilibrium as time passes.

```
q3_1 = dsolve(ode1, x(0) == 5); % Start at non-equilibrium point
q3_2 = dsolve(ode2, x(0) == 5); % Start at non-equilibrium point

figure;
fplot(real(q3_1(1)))
hold on;
fplot(real(q3_2(1)))

xlim([0, 6]);
ylim([-1*10^4, 10*10^4]);
```



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