Problem 2 c)

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In this code, we verify that the mechanical energy of the system remains constant through time.

Parameters

```
close all
clear all
clc

m=0.5;          %kg
r=1;            %m
g=9.81;         %m/s^2

% Initial conditions (arbitrary)
q0=[pi/3; 0];    %rad
dq0=[0; pi];     %rad/s
x0=[q0;dq0];

% Integration limits
tspan=[0 10];   %s
```

Useful functions

Mass matrix

```
M=@(q) m*r^2*diag([1,sin(q(1))^2]);
invM=@(q) 1/(m*r^2)*diag([1,1/(sin(q(1))^2)]);

% Non linear forces
fnon=@(q,dq) [0.5*m*r^2*(dq(2)).^2*sin(2*q(1))+m*g*r*sin(q(1)) ;...
              -m*r^2*dq(2).*dq(1)*sin(2*q(1))];

% Function to integrate
f=@(t,x) [x([3 4]) ; invM(x([1 2]))*fnon(x([1 2]),x([3 4]))];
```

Integration

```
options = odeset('RelTol',1e-10);
[t,x] = ode45(f,tspan,x0,options);
```

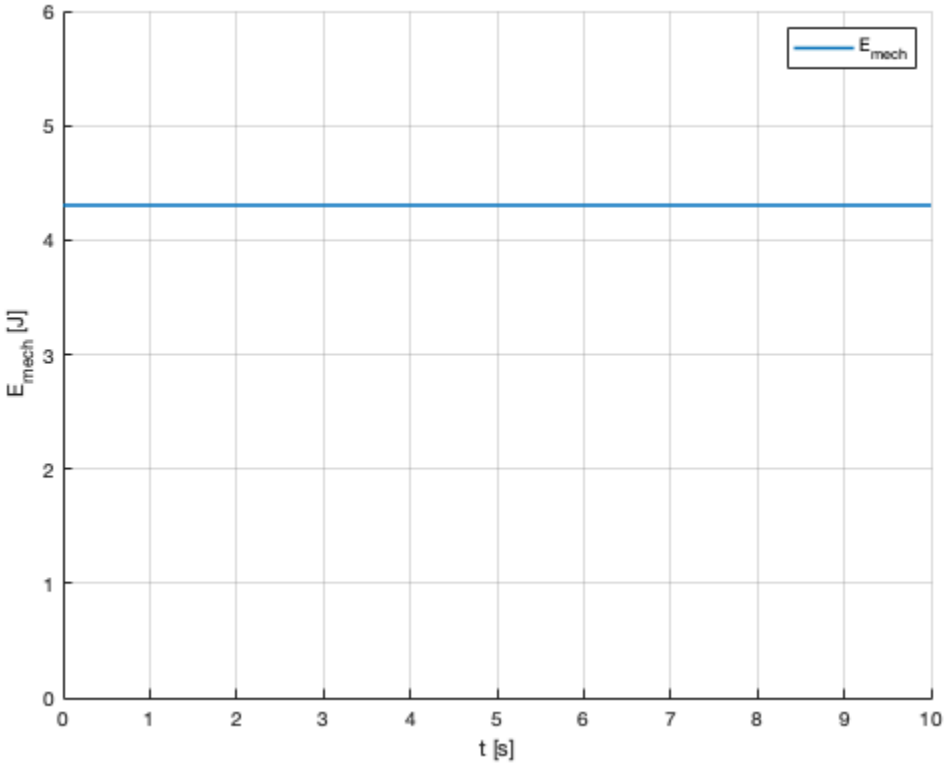
Energies

```
Tpw_a=@(x) 0.5*x([3 4])'*M(x([1 2]))*x([3 4]);
Upw=@(x) m*g*r*cos(x(1));
Epw_a=@(x) Tpw_a(x)+Upw(x);

Emech=NaN(length(t),1);
T=NaN(length(t),1);
U=NaN(length(t),1);
for i=1:length(t)
    Emech(i)=Epw_a(x(i,:)');
    T(i)=Tpw_a(x(i,:)');
    U(i)=Upw(x(i,:)');
end
```

Plot

```
figure('Numbertitle','off','Name','Mechanical Energy');
grid on
hold on
plot(t,Emech,'LineWidth',1.5,'DisplayName','E_{mech}');
ylim([0 6]);
xlabel('t [s]');ylabel('E_{mech} [J]');
legend show
```



Comments

As expected, the mechanical energy is constant through time. This is a good indicator of a correct dynamics analysis.

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