clear variables

syms m1 l1 r1 I1 m2 l2 r2 I2 g

syms theta1(t) theta2(t)

x1 = r1\*cos(theta1)

y1 = r1\*sin(theta1)

z1 = 0;

x2 = l1\*cos(theta1) + r2\*cos(theta1+theta2)

y2 = l1\*sin(theta1) + r2\*sin(theta1+theta2)

z2 = 0;

% potential energy of the system

P = m1\*g\*y1 + m2\*g\*y2

Jv1 = [diff(x1,theta1) diff(x1,theta2)

diff(y1,theta1) diff(y1,theta2)

diff(z1,theta1) diff(z1,theta2)]

Jv2 = [diff(x2,theta1) diff(x2,theta2)

diff(y2,theta1) diff(y2,theta2)

diff(z2,theta1) diff(z2,theta2)]

Jw1 = sym([0 0; 0 0; 1 0])

Jw2 = sym([0 0; 0 0; 1 1])

R1 = [cos(theta1) -sin(theta1) 0;

sin(theta1) cos(theta1) 0;

0 0 1]

R2 = [cos(theta2) -sin(theta2) 0;

sin(theta2) cos(theta2) 0;

0 0 1]

M = m1\*(Jv1.'\*Jv1) + Jw1.'\*R1\*I1\*R1.'\*Jw1 + ...

m2\*(Jv2.'\*Jv2) + Jw2.'\*R2\*I2\*R2.'\*Jw2;

M = simplify(M)

M = M(t); % evaluate vs. time so we can index the matrix

c11 = 1/2\*(diff(M(1,1),theta1) + diff(M(1,1),theta1) - diff(M(1,1),theta1)) \* diff(theta1(t),t) + ...

1/2\*(diff(M(1,1),theta2) + diff(M(1,2),theta1) - diff(M(2,1),theta1)) \* diff(theta2(t),t);

c12 = 1/2\*(diff(M(1,2),theta1) + diff(M(1,1),theta2) - diff(M(1,2),theta1)) \* diff(theta1(t),t) + ...

1/2\*(diff(M(1,2),theta2) + diff(M(1,2),theta2) - diff(M(2,2),theta1)) \* diff(theta2(t),t);

c21 = 1/2\*(diff(M(2,1),theta1) + diff(M(2,1),theta1) - diff(M(1,1),theta2)) \* diff(theta1(t),t) + ...

1/2\*(diff(M(2,1),theta2) + diff(M(2,2),theta1) - diff(M(2,1),theta2)) \* diff(theta2(t),t);

c22 = 1/2\*(diff(M(2,2),theta1) + diff(M(2,1),theta2) - diff(M(1,2),theta2)) \* diff(theta1(t),t) + ...

1/2\*(diff(M(2,2),theta2) + diff(M(2,2),theta2) - diff(M(2,2),theta2)) \* diff(theta2(t),t);

C = simplify([c11 c12; c21 c22])

Tg = [diff(P,theta1); diff(P,theta2)];

Tg = simplify(Tg)