clear variables

syms m1 l1 r1 I1 m2 l2 r2 I2 g

syms alpha1(t) alpha2(t)

x1 = r1\*cos(alpha1)

y1 = r1\*sin(alpha1)

z1 = 0;

x2 = l1\*cos(alpha1) + r2\*cos(alpha2)

y2 = l1\*sin(alpha1) + r2\*sin(alpha2)

z2 = 0;

% potential energy of the system

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

Jv1 = [diff(x1,alpha1) diff(x1,alpha2)

diff(y1,alpha1) diff(y1,alpha2)

diff(z1,alpha1) diff(z1,alpha2)]

Jv2 = [diff(x2,alpha1) diff(x2,alpha2)

diff(y2,alpha1) diff(y2,alpha2)

diff(z2,alpha1) diff(z2,alpha2)]

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

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

R1 = [cos(alpha1) -sin(alpha1) 0;

sin(alpha1) cos(alpha1) 0;

0 0 1]

R2 = [cos(alpha2) -sin(alpha2) 0;

sin(alpha2) cos(alpha2) 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),alpha1) + diff(M(1,1),alpha1) - diff(M(1,1),alpha1)) \* diff(alpha1(t),t) + ...

1/2\*(diff(M(1,1),alpha2) + diff(M(1,2),alpha1) - diff(M(2,1),alpha1)) \* diff(alpha2(t),t);

c12 = 1/2\*(diff(M(1,2),alpha1) + diff(M(1,1),alpha2) - diff(M(1,2),alpha1)) \* diff(alpha1(t),t) + ...

1/2\*(diff(M(1,2),alpha2) + diff(M(1,2),alpha2) - diff(M(2,2),alpha1)) \* diff(alpha2(t),t);

c21 = 1/2\*(diff(M(2,1),alpha1) + diff(M(2,1),alpha1) - diff(M(1,1),alpha2)) \* diff(alpha1(t),t) + ...

1/2\*(diff(M(2,1),alpha2) + diff(M(2,2),alpha1) - diff(M(2,1),alpha2)) \* diff(alpha2(t),t);

c22 = 1/2\*(diff(M(2,2),alpha1) + diff(M(2,1),alpha2) - diff(M(1,2),alpha2)) \* diff(alpha1(t),t) + ...

1/2\*(diff(M(2,2),alpha2) + diff(M(2,2),alpha2) - diff(M(2,2),alpha2)) \* diff(alpha2(t),t);

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

Tg = [diff(P,alpha1); diff(P,alpha2)];

Tg = simplify(Tg)