```
% General dynamics of a robot example

clc;
clear;

syms L g m1 m2 theta1 theta2 theta1_dot theta2_dot theta1_dot_dot theta2_dot_dot
Ix1 Ix2 Ix3 Iy1 Iy2 Iy3 Iz1 Iz2 real

theta = [theta1; theta2];
thetadot = [theta1_dot; theta2_dot];
thetadotdot = [theta1_dot_dot; theta2_dot_dot];
M1 = [eye(3),[0;0;0]; 0 0 0 1]; % home matrix for link 1
M2 = [eye(3), [L;0;0]; 0 0 0 1]; % home matrix for link 2

S1 = [0;0;0;1;0;0]; % Prismatic joint
S2 = [0;0;1;0;0;0]; % Revolute joint

S_eq1 = [S1, [0;0;0;0;0;0]]; % First focus: till first center of mass, a.k.a S2 ==
0
S_eq2 = [S1, S2];  % Second focus: till second center of mass, a.k.a S1 == S1, S2
== S2 ... continued

T_1 = fk(M1, S_eq1, theta);
R_1 = T_1(1:3, 1:3);
JS_1 = simplify(expand(JacS(S_eq1, theta))); % Space Jacobian
Jb_1 = double(adjointM(inv(T_1))*JS_1); % Body Jacobian
J_geometric_1 = simplify(expand([R_1, zeros(3); zeros(3), R_1] * Jb_1)); %
Geometric Jacobian
Jw1 = J_geometric_1(1:3,1:2);
Jv1 = J_geometric_1(4:6, 1:2);
Inertia_1 = [[Ix1 0 0]
    [0 Iy1 0]
    [0 0 Iz1]];


T_2 = fk(M2, S_eq2, theta)
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T_2 =

$$\begin{pmatrix} \cos(\theta_2) & -\sin(\theta_2) & 0 & \theta_1 + L\cos(\theta_2) \\ \sin(\theta_2) & \cos(\theta_2) & 0 & L\sin(\theta_2) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

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R_2 = T_2(1:3, 1:3);
JS_2 = simplify(expand(JacS(S_eq2, theta))); % Space Jacobian
Jb_2 = adjointM(inv(T_2))*JS_2; % Body Jacobian
J_geometric_2 = simplify(expand([R_2, zeros(3); zeros(3), R_2] * Jb_2)); %
Geometric Jacobian
Jw2 = J_geometric_2(1:3,1:2);
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Jv2 = J_geometric_2(4:6, 1:2);

Inertia_2 = [[Ix2 0 0]
    [0 Iy2 0]
    [0 0 Iz2]];

Mass_Matrix = simplify(expand(m1*(Jv1'*Jv1) + Jw1'*R_1*Inertia_1*R_1'*Jw1 +
m2*(Jv2'*Jv2) + Jw2'*R_2*Inertia_2*R_2'*Jw2))
```

Mass_Matrix =

$$\begin{pmatrix} m_1 + m_2 & -L\, m_2 \sin(\theta_2) \\ -L\, m_2 \sin(\theta_2) & m_2\, L^2 + \mathrm{Iz}_2 \end{pmatrix}$$

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Coriolis_Matrix = simplify(coriolis(Mass_Matrix, theta, thetadot))
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Coriolis_Matrix =

$$\begin{pmatrix} 0 & -L\, m_2\, \dot{\theta}_2 \cos(\theta_2) \\ 0 & 0 \end{pmatrix}$$

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h1 = T_1(2, 4)
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h1 = 0

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h2 = T_2(2, 4)
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h2 = $L \sin(\theta_2)$

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P = g*m1*h1 + g*m2*h2;

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

$$\begin{pmatrix} 0 \\ L\, g\, m_2 \cos(\theta_2) \end{pmatrix}$$

```
tau = (Mass_Matrix*thetadotdot + Coriolis_Matrix*thetadot + gravity_vector)
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tau =

$$\begin{pmatrix} -L\, m_2 \cos(\theta_2)\, \dot{\theta}_2^{\,2} + \ddot{\theta}_1\, (m_1 + m_2) - L\, m_2\, \ddot{\theta}_2 \sin(\theta_2) \\ \ddot{\theta}_2\, \left(m_2\, L^2 + \mathrm{Iz}_2\right) + L\, g\, m_2 \cos(\theta_2) - L\, m_2\, \ddot{\theta}_1 \sin(\theta_2) \end{pmatrix}$$