The given solutions assume that the a=1 dimension is always in the x-direction. The following solutions assume that the a=1 dimension is always along the long axis of the link as shown in the homework. This will end up changing the inertia tensors, which trickles down.

In[757]:=
```
ClearAll["Global`*"]
Needs["Screws`", "C:\\Mathematica\\Screws.m"]
Needs["RobotLinks`", "C:\\Mathematica\\RobotLinks.m"]
Needs["VariationalMethods`"]
```

Problem 1: Two-link RR manipulator

In[761]:=
```
m = 2;
a = 1;
b = 0.2;
c = 0;

θ = {θ1[t], θ2[t]};
θdot = D[θ, t];

xi1 = {0, 0, 0, 0, 0, 1};
xi2 = {0, -a, 0, 0, 0, 1};

gst0b1 = {{1, 0, 0, a / 2}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};
gst0b2 = {{1, 0, 0, a + a / 2}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};

e1 = TwistExp[xi1, θ[[1]]];
e2 = TwistExp[xi2, θ[[2]]];

gstb1 = TwistExp[xi1, θ[[1]]].gst0b1;
gstb2 = TwistExp[xi1, θ[[1]]].TwistExp[xi2, θ[[2]]].gst0b2 // FullSimplify;

Labeled[MatrixForm[COM1 = RigidPosition[gstb1]], "COM1"]
Labeled[MatrixForm[COM2 = RigidPosition[gstb2]], "COM2"]
Labeled[
 MatrixForm[I1 = {{m / 12 * (b^2 + c^2), 0, 0}, {0, m / 12 * (a^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor]
I2 = I1;

GenM1 = {{m * IdentityMatrix[3], 0}, {0, I1}} // ArrayFlatten;
```

```
GenM2 = {{m * IdentityMatrix[3], 0}, {0, I2}} // ArrayFlatten;

xi1cross = Inverse[RigidAdjoint[e1.gst0b1]].xi1 // Simplify;
Jbsl1 = {xi1cross, {0, 0, 0, 0, 0, 0}} // Transpose;

xi1cross = Inverse[RigidAdjoint[e1.e2.gst0b2]].xi1 // Simplify;
xi2cross = Inverse[RigidAdjoint[e2.gst0b2]].xi2 // Simplify;
Jbsl2 = {xi1cross, xi2cross} // Transpose;

M = Transpose[Jbsl1].GenM1.Jbsl1 + Transpose[Jbsl2].GenM2.Jbsl2 // Simplify;

P = m * g * COM1⟦2⟧ + m * g * COM2⟦2⟧;
G = {0, 0};
G⟦1⟧ = D[P, θ⟦1⟧];
G⟦2⟧ = D[P, θ⟦2⟧];
christoffel = ConstantArray[0, {2, 2, 2}];

For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  For[k = 1, k ≤ 2, k++,
   christoffel⟦i, j, k⟧ = 1 / 2 * (D[M⟦i, j⟧, θ⟦k⟧] + D[M⟦i, k⟧, θ⟦j⟧] - D[M⟦k, j⟧, θ⟦i⟧]);
  ]
 ]
]

MatrixForm[christoffel];

Coriolis = ConstantArray[0, {2, 2}];
For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  Coriolis⟦i, j⟧ = christoffel⟦i, j, All⟧.θdot;
 ]
]
```

```
K = 1 / 2 * Transpose[θdot].M.θdot;
L = K - P // FullSimplify;

EL = {0, 0};
For [i = 1, i ≤ 2, i++,
 EL[[i]] = D[D[L, θdot[[i]]], t] - D[L, θ[[i]]];
]

Labeled[MatrixForm[EL // FullSimplify], "Euler-Lagrange Equations"]

Labeled[MatrixForm[M], "M(θ)"]
Labeled[MatrixForm[Coriolis // FullSimplify], "C(θ,θ̇)"]
MatrixForm[InertiaToCoriolis[M, θ, θdot] // FullSimplify];
Labeled[MatrixForm[G // FullSimplify], "G(θ)"]

Labeled[MatrixForm[D[M, t] - 2 * Coriolis // Simplify], "(Ṁ - 2C)"]
MatrixForm[D[M, t] - 2 * Coriolis // Simplify] == MatrixForm[-1 * Transpose[D[M, t] - 2 * Coriolis // Simplify]]
```

Out[775]=

$$\begin{pmatrix} \frac{1}{2}\,\text{Cos}[\theta 1[t]] \\ \frac{1}{2}\,\text{Sin}[\theta 1[t]] \\ 0 \end{pmatrix}$$

COM1

Out[776]=

$$\begin{pmatrix} \text{Cos}[\theta 1[t]] + \frac{1}{2}\,\text{Cos}[\theta 1[t] + \theta 2[t]] \\ \text{Sin}[\theta 1[t]] + \frac{1}{2}\,\text{Sin}[\theta 1[t] + \theta 2[t]] \\ 0 \end{pmatrix}$$

COM2

Out[777]=

$$\begin{pmatrix} 0.00666667 & 0 & 0 \\ 0 & \frac{1}{6} & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$$

Inertia Tensor

Out[800]=

$$\begin{pmatrix} g\,(3.\,\text{Cos}[\theta 1[t]] + \text{Cos}[\theta 1[t] + \theta 2[t]]) - \text{Sin}[\theta 2[t]]\,\theta 2'[t]\,(2\,\theta 1'[t] + \theta 2'[t]) + 2.\,(1.673 + \text{Cos}[\theta 2[t]])\,\theta 1''[t] + (0.673 + \text{Cos}[\theta 2[t]])\theta 2''[t] \\ g\,\text{Cos}[\theta 1[t] + \theta 2[t]] + \text{Sin}[\theta 2[t]]\,\theta 1'[t]^2 + (0.673333 + \text{Cos}[\theta 2[t]])\,\theta 1''[t] + 0.673333\,\theta 2''[t] \end{pmatrix}$$

Euler–Lagrange Equations

Out[801]=

$$\begin{pmatrix} 2.\,(1.67333 + \text{Cos}[\theta 2[t]]) & 0.673333 + \text{Cos}[\theta 2[t]] \\ 0.673333 + \text{Cos}[\theta 2[t]] & 0.673333 \end{pmatrix}$$

$M(\theta)$

Out[802]=

$$\begin{pmatrix} -1.\,\text{Sin}[\theta 2[t]]\,\theta 2'[t] & -1.\,\text{Sin}[\theta 2[t]]\,(\theta 1'[t] + \theta 2'[t]) \\ \text{Sin}[\theta 2[t]]\,\theta 1'[t] & 0 \end{pmatrix}$$

$C(\theta,\dot{\theta})$

Out[804]=

$$\begin{pmatrix} g\,(3\,\text{Cos}[\theta 1[t]] + \text{Cos}[\theta 1[t] + \theta 2[t]]) \\ g\,\text{Cos}[\theta 1[t] + \theta 2[t]] \end{pmatrix}$$

$G(\theta)$

Out[805]=

$$\begin{pmatrix} 0. & \text{Sin}[\theta 2[t]]\,(2.\,\theta 1'[t] + \theta 2'[t]) \\ -\text{Sin}[\theta 2[t]]\,(2\,\theta 1'[t] + \theta 2'[t]) & 0 \end{pmatrix}$$

$(\dot{M} - 2C)$

Out[806]= True

Problem 2: Two-link PP manipulator

In[807]:=

```
m = 2;
a = 1;
b = 0.2;
c = 0;

θ = {θ1[t], θ2[t]};
θdot = D[θ, t];

xi1 = {1, 0, 0, 0, 0, 0};
xi2 = {0, 1, 0, 0, 0, 0};

gst0b1 = {{1, 0, 0, 0}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};
```

```
gst0b2 = {{0, -1, 0, a / 2}, {1, 0, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};

e1 = TwistExp[xi1, θ⟦1⟧];
e2 = TwistExp[xi2, θ⟦2⟧];

gstb1 = TwistExp[xi1, θ⟦1⟧].gst0b1;
gstb2 = TwistExp[xi1, θ⟦1⟧].TwistExp[xi2, θ⟦2⟧].gst0b2 // FullSimplify;

Labeled[MatrixForm[COM1 = RigidPosition[gstb1]], "COM1"]
Labeled[MatrixForm[COM2 = RigidPosition[gstb2]], "COM2"]
Labeled[
 MatrixForm[I1 = {{m / 12 * (b^2 + c^2), 0, 0}, {0, m / 12 * (a^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor1]
Labeled[
 MatrixForm[I2 = {{m / 12 * (a^2 + c^2), 0, 0}, {0, m / 12 * (b^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor2]

GenM1 = {{m * IdentityMatrix[3], 0}, {0, I1}} // ArrayFlatten;
GenM2 = {{m * IdentityMatrix[3], 0}, {0, I2}} // ArrayFlatten;

xi1cross = Inverse[RigidAdjoint[e1.gst0b1]].xi1 // Simplify;
Jbsl1 = {xi1cross, {0, 0, 0, 0, 0, 0}} // Transpose;

xi1cross = Inverse[RigidAdjoint[e1.e2.gst0b2]].xi1 // Simplify;
xi2cross = Inverse[RigidAdjoint[e2.gst0b2]].xi2 // Simplify;
Jbsl2 = {xi1cross, xi2cross} // Transpose;

M = Transpose[Jbsl1].GenM1.Jbsl1 + Transpose[Jbsl2].GenM2.Jbsl2 // Simplify;

P = m * g * COM1⟦2⟧ + m * g * COM2⟦2⟧;
G = {0, 0};
G⟦1⟧ = D[P, θ⟦1⟧];
G⟦2⟧ = D[P, θ⟦2⟧];
christoffel = ConstantArray[0, {2, 2, 2}];

For[i = 1, i ≤ 2, i++,
```

```
 For [j = 1, j ≤ 2, j++,
  For[k = 1, k ≤ 2, k++,
   christoffel[[i, j, k]] = 1 / 2 * (D[M[[i, j]], θ[[k]]] + D[M[[i, k]], θ[[j]]] - D[M[[k, j]], θ[[i]]]);
  ]
 ]
]

MatrixForm[christoffel];

Coriolis = ConstantArray[0, {2, 2}];
For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  Coriolis[[i, j]] = christoffel[[i, j, All]].θdot;
 ]
]

K = 1 / 2 * Transpose[θdot].M.θdot;
L = K - P // FullSimplify;

EL = {0, 0};
For [i = 1, i ≤ 2, i++,
 EL[[i]] = D[D[L, θdot[[i]]], t] - D[L, θ[[i]]];
]

Labeled[MatrixForm[EL // FullSimplify], "Euler-Lagrange Equations"]

Labeled[MatrixForm[M], "M(θ)"]
Labeled[MatrixForm[Coriolis // FullSimplify], "C(θ,θ̇)"]
MatrixForm[InertiaToCoriolis[M, θ, θdot] // FullSimplify];
Labeled[MatrixForm[G // FullSimplify], "G(θ)"]

Labeled[MatrixForm[D[M, t] - 2 * Coriolis // Simplify], "(Ṁ - 2C)"]
MatrixForm[D[M, t] - 2 * Coriolis // Simplify] == MatrixForm[-1 * Transpose[D[M, t] - 2 * Coriolis // Simplify]]
```

Out[821]= $\begin{pmatrix} \theta1[t] \\ 0 \\ 0 \end{pmatrix}$
COM1

Out[822]= $\begin{pmatrix} \frac{1}{2} + \theta1[t] \\ \theta2[t] \\ 0 \end{pmatrix}$
COM2

Out[823]= $\begin{pmatrix} 0.00666667 & 0 & 0 \\ 0 & \frac{1}{6} & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$
Inertia Tensor1

Out[824]= $\begin{pmatrix} \frac{1}{6} & 0 & 0 \\ 0 & 0.00666667 & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$
Inertia Tensor2

Out[846]= $\begin{pmatrix} 4.\ \theta1''[t] \\ 2\ (g + \theta2''[t]) \end{pmatrix}$
Euler–Lagrange Equations

Out[847]= $\begin{pmatrix} 4. & 0. \\ 0. & 2. \end{pmatrix}$
$M(\theta)$

Out[848]= $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$
$C(\theta, \dot{\theta})$

Out[850]= $\begin{pmatrix} 0 \\ 2\,g \end{pmatrix}$
$G(\theta)$

Out[851]=
$$\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

$(\dot{M} - 2C)$

Out[852]= True

Problem 3: Two-link PR manipulator

In[853]:=
```
m = 2;
a = 1;
b = 0.2;
c = 0;

θ = {θ1[t], θ2[t]};
θdot = D[θ, t];

xi1 = {1, 0, 0, 0, 0, 0};
xi2 = {0, a / 2, 0, 0, 0, 1};

gst0b1 = {{1, 0, 0, 0}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};
gst0b2 = {{1, 0, 0, a}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};

e1 = TwistExp[xi1, θ[[1]]];
e2 = TwistExp[xi2, θ[[2]]];

gstb1 = TwistExp[xi1, θ[[1]]].gst0b1;
gstb2 = TwistExp[xi1, θ[[1]]].TwistExp[xi2, θ[[2]]].gst0b2 // FullSimplify;

Labeled[MatrixForm[COM1 = RigidPosition[gstb1]], "COM1"]
Labeled[MatrixForm[COM2 = RigidPosition[gstb2]], "COM2"]
Labeled[
 MatrixForm[I1 = {{m / 12 * (b^2 + c^2), 0, 0}, {0, m / 12 * (a^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor]
I2 = I1;
```

```
GenM1 = {{m * IdentityMatrix[3], 0}, {0, I1}} // ArrayFlatten;
GenM2 = {{m * IdentityMatrix[3], 0}, {0, I2}} // ArrayFlatten;

xi1cross = Inverse[RigidAdjoint[e1.gst0b1]].xi1 // Simplify;
Jbsl1 = {xi1cross, {0, 0, 0, 0, 0, 0}} // Transpose;

xi1cross = Inverse[RigidAdjoint[e1.e2.gst0b2]].xi1 // Simplify;
xi2cross = Inverse[RigidAdjoint[e2.gst0b2]].xi2 // Simplify;
Jbsl2 = {xi1cross, xi2cross} // Transpose;

M = Transpose[Jbsl1].GenM1.Jbsl1 + Transpose[Jbsl2].GenM2.Jbsl2 // Simplify;

P = m * g * COM1[[2]] + m * g * COM2[[2]];
G = {0, 0};
G[[1]] = D[P, θ[[1]]];
G[[2]] = D[P, θ[[2]]];
christoffel = ConstantArray[0, {2, 2, 2}];

For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  For[k = 1, k ≤ 2, k++,
   christoffel[[i, j, k]] = 1 / 2 * (D[M[[i, j]], θ[[k]]] + D[M[[i, k]], θ[[j]]] - D[M[[k, j]], θ[[i]]]);
  ]
 ]
]

MatrixForm[christoffel];

Coriolis = ConstantArray[0, {2, 2}];
For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  Coriolis[[i, j]] = christoffel[[i, j, All]].θdot;
 ]
]
```

```
K = 1 / 2 * Transpose[θdot].M.θdot;
L = K - P // FullSimplify;

EL = {0, 0};
For [i = 1, i ≤ 2, i++,
 EL[[i]] = D[D[L, θdot[[i]]], t] - D[L, θ[[i]]];
]

Labeled[MatrixForm[EL // FullSimplify], "Euler-Lagrange Equations"]

Labeled[MatrixForm[M], "M(θ)"]
Labeled[MatrixForm[Coriolis // FullSimplify], "C(θ,θ̇)"]
MatrixForm[InertiaToCoriolis[M, θ, θdot] // FullSimplify];
Labeled[MatrixForm[G // FullSimplify], "G(θ)"]

Labeled[MatrixForm[D[M, t] - 2 * Coriolis // Simplify], "(Ṁ - 2C)"]
MatrixForm[D[M, t] - 2 * Coriolis // Simplify] == MatrixForm[-1 * Transpose[D[M, t] - 2 * Coriolis // Simplify]]
```

Out[867]=
$$\begin{pmatrix} \theta 1[t] \\ 0 \\ 0 \end{pmatrix}$$
COM1

Out[868]=
$$\begin{pmatrix} -\frac{1}{2} + \frac{3}{2} \mathrm{Cos}[\theta 2[t]] + \theta 1[t] \\ \frac{3}{2} \mathrm{Sin}[\theta 2[t]] \\ 0 \end{pmatrix}$$
COM2

Out[869]=
$$\begin{pmatrix} 0.00666667 & 0 & 0 \\ 0 & \frac{1}{6} & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$$
Inertia Tensor

Out[892]=
$$\begin{pmatrix} -3.\ \left(\text{Cos}[\theta 2[t]]\ \theta 2'[t]^2 - 1.33333\ \theta 1''[t] + \text{Sin}[\theta 2[t]]\ \theta 2''[t]\right) \\ 3.\ g\ \text{Cos}[\theta 2[t]] - 3.\ \text{Sin}[\theta 2[t]]\ \theta 1''[t] + 4.67333\ \theta 2''[t] \end{pmatrix}$$
Euler−Lagrange Equations

Out[893]=
$$\begin{pmatrix} 4. & -3\ \text{Sin}[\theta 2[t]] \\ -3\ \text{Sin}[\theta 2[t]] & 4.67333 \end{pmatrix}$$
M(θ)

Out[894]=
$$\begin{pmatrix} 0 & -3\ \text{Cos}[\theta 2[t]]\ \theta 2'[t] \\ 0 & 0 \end{pmatrix}$$
$C(\theta,\dot{\theta})$

Out[896]=
$$\begin{pmatrix} 0 \\ 3\ g\ \text{Cos}[\theta 2[t]] \end{pmatrix}$$
G(θ)

Out[897]=
$$\begin{pmatrix} 0 & 3\ \text{Cos}[\theta 2[t]]\ \theta 2'[t] \\ -3\ \text{Cos}[\theta 2[t]]\ \theta 2'[t] & 0 \end{pmatrix}$$
$(\dot{M} - 2C)$

Out[898]= True

Problem 4: Two-link RP manipulator

In[899]:=

```
m = 2;
a = 1;
b = 0.2;
c = 0;

θ = {θ1[t], θ2[t]};
θdot = D[θ, t];

xi1 = {0, 0, 0, 0, 0, 1};
xi2 = {0, 1, 0, 0, 0, 0};

gst0b1 = {{1, 0, 0, a / 2}, {0, 1, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};
```

```
gst0b2 = {{0, -1, 0, a}, {1, 0, 0, 0}, {0, 0, 1, 0}, {0, 0, 0, 1}};

e1 = TwistExp[xi1, θ[[1]]];
e2 = TwistExp[xi2, θ[[2]]];

gstb1 = TwistExp[xi1, θ[[1]]].gst0b1;
gstb2 = TwistExp[xi1, θ[[1]]].TwistExp[xi2, θ[[2]]].gst0b2 // FullSimplify;

Labeled[MatrixForm[COM1 = RigidPosition[gstb1]], "COM1"]
Labeled[MatrixForm[COM2 = RigidPosition[gstb2]], "COM2"]
Labeled[
 MatrixForm[I1 = {{m / 12 * (b^2 + c^2), 0, 0}, {0, m / 12 * (a^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor1]
Labeled[
 MatrixForm[I1 = {{m / 12 * (a^2 + c^2), 0, 0}, {0, m / 12 * (b^2 + c^2), 0}, {0, 0, m / 12 * (a^2 + b^2)}}], Inertia Tensor2]

GenM1 = {{m * IdentityMatrix[3], 0}, {0, I1}} // ArrayFlatten;
GenM2 = {{m * IdentityMatrix[3], 0}, {0, I2}} // ArrayFlatten;

xi1cross = Inverse[RigidAdjoint[e1.gst0b1]].xi1 // Simplify;
Jbsl1 = {xi1cross, {0, 0, 0, 0, 0, 0}} // Transpose;

xi1cross = Inverse[RigidAdjoint[e1.e2.gst0b2]].xi1 // Simplify;
xi2cross = Inverse[RigidAdjoint[e2.gst0b2]].xi2 // Simplify;
Jbsl2 = {xi1cross, xi2cross} // Transpose;

M = Transpose[Jbsl1].GenM1.Jbsl1 + Transpose[Jbsl2].GenM2.Jbsl2 // Simplify;

P = m * g * COM1[[2]] + m * g * COM2[[2]];
G = {0, 0};
G[[1]] = D[P, θ[[1]]];
G[[2]] = D[P, θ[[2]]];
christoffel = ConstantArray[0, {2, 2, 2}];

For[i = 1, i ≤ 2, i++,
```

```
 For [j = 1, j ≤ 2, j++,
  For[k = 1, k ≤ 2, k++,
   christoffel⟦i, j, k⟧ = 1 / 2 * (D[M⟦i, j⟧, θ⟦k⟧] + D[M⟦i, k⟧, θ⟦j⟧] - D[M⟦k, j⟧, θ⟦i⟧]);
  ]
 ]
]

MatrixForm[christoffel];

Coriolis = ConstantArray[0, {2, 2}];
For[i = 1, i ≤ 2, i++,
 For [j = 1, j ≤ 2, j++,
  Coriolis⟦i, j⟧ = christoffel⟦i, j, All⟧.θdot;
 ]
]

K = 1 / 2 * Transpose[θdot].M.θdot;
L = K - P // FullSimplify;

EL = {0, 0};
For [i = 1, i ≤ 2, i++,
 EL⟦i⟧ = D[D[L, θdot⟦i⟧], t] - D[L, θ⟦i⟧];
]

Labeled[MatrixForm[EL // FullSimplify], "Euler-Lagrange Equations"]

Labeled[MatrixForm[M], "M(θ)"]
Labeled[MatrixForm[Coriolis // FullSimplify], "C(θ,θ̇)"]
MatrixForm[InertiaToCoriolis[M, θ, θdot] // FullSimplify];
Labeled[MatrixForm[G // FullSimplify], "G(θ)"]

Labeled[MatrixForm[D[M, t] - 2 * Coriolis // Simplify], "(Ṁ - 2C)"]
MatrixForm[D[M, t] - 2 * Coriolis // Simplify] == MatrixForm[-1 * Transpose[D[M, t] - 2 * Coriolis // Simplify]]
```

Out[913]=
$$\begin{pmatrix} \frac{1}{2}\,\mathrm{Cos}[\theta 1[t]] \\ \frac{1}{2}\,\mathrm{Sin}[\theta 1[t]] \\ 0 \end{pmatrix}$$
COM1

Out[914]=
$$\begin{pmatrix} \mathrm{Cos}[\theta 1[t]] - \mathrm{Sin}[\theta 1[t]]\,\theta 2[t] \\ \mathrm{Sin}[\theta 1[t]] + \mathrm{Cos}[\theta 1[t]]\,\theta 2[t] \\ 0 \end{pmatrix}$$
COM2

Out[915]=
$$\begin{pmatrix} 0.00666667 & 0 & 0 \\ 0 & \frac{1}{6} & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$$
Inertia Tensor1

Out[916]=
$$\begin{pmatrix} \frac{1}{6} & 0 & 0 \\ 0 & 0.00666667 & 0 \\ 0 & 0 & 0.173333 \end{pmatrix}$$
Inertia Tensor2

Out[938]=
$$\begin{pmatrix} 3.\,g\,\mathrm{Cos}[\theta 1[t]] + 2.84667\,\theta 1''[t] + \theta 2[t]\,(-2.\,g\,\mathrm{Sin}[\theta 1[t]] + 4\,\theta 1'[t]\,\theta 2'[t] + 2\,\theta 2[t]\,\theta 1''[t]) + 2.\,\theta 2''[t] \\ 2.\,\left(g\,\mathrm{Cos}[\theta 1[t]] - 1.\,\theta 2[t]\,\theta 1'[t]^2 + \theta 1''[t] + \theta 2''[t]\right) \end{pmatrix}$$
Euler−Lagrange Equations

Out[939]=
$$\begin{pmatrix} 2.84667 + 2\,\theta 2[t]^2 & 2. \\ 2. & 2. \end{pmatrix}$$
M(θ)

Out[940]=
$$\begin{pmatrix} 2\,\theta 2[t]\,\theta 2'[t] & 2\,\theta 2[t]\,\theta 1'[t] \\ -2\,\theta 2[t]\,\theta 1'[t] & 0 \end{pmatrix}$$
C(θ,$\dot{\theta}$)

Out[942]=
$$\begin{pmatrix} g\,(3\,\mathrm{Cos}[\theta 1[t]] - 2\,\mathrm{Sin}[\theta 1[t]]\,\theta 2[t]) \\ 2\,g\,\mathrm{Cos}[\theta 1[t]] \end{pmatrix}$$
G(θ)

Out[943]= $\begin{pmatrix} 0 & -4\,\theta 2[t]\,\theta 1'[t] \\ 4\,\theta 2[t]\,\theta 1'[t] & 0 \end{pmatrix}$

$(\dot{M} - 2C)$

Out[944]= True

In[945]:=