In[1]:=
```
SetDirectory[NotebookDirectory[]]
<< "ToMatlab.m"
```

Out[1]=
```
/home/nathan/olin/fall2016/QEA-BB8/v2
```

In[3]:=
```
eq = {
   m2 (x0''[t] + R (θ''[t] Cos[θ[t]] - θ'[t]^2 Sin[θ[t]])) ==
    -f2[t] Cos[θ[t]] + Fn2[t] Sin[θ[t]],
   m2 R (-θ''[t] Sin[θ[t]] - θ'[t]^2 Cos[θ[t]]) == f2[t] Sin[θ[t]] + Fn2[t] Cos[θ[t]] - m2 g,
   f2[t] - f1[t] == (x0''[t] / R^2) i,
   f1[t] + f2[t] Cos[θ[t]] - Fn2[t] Sin[θ[t]] == m1 x0''[t]
  };
Column[Simplify@eq, Frame → All] // TraditionalForm
```

Out[4]//TraditionalForm=

$\text{f2}(t)\cos(\theta(t)) + \text{m2}\left(R\,\theta''(t)\cos(\theta(t)) - R\,\theta'(t)^2\sin(\theta(t)) + \text{x0}''(t)\right) = \text{Fn2}(t)\sin(\theta(t))$
$g\,\text{m2} = \text{f2}(t)\sin(\theta(t)) + \text{Fn2}(t)\cos(\theta(t)) + \text{m2}\,R\,\theta''(t)\sin(\theta(t)) + \text{m2}\,R\,\theta'(t)^2\cos(\theta(t))$
$\text{f2}(t) = \text{f1}(t) + \frac{i\,\text{x0}''(t)}{R^2}$
$\text{f1}(t) + \text{f2}(t)\cos(\theta(t)) = \text{Fn2}(t)\sin(\theta(t)) + \text{m1}\,\text{x0}''(t)$

In[5]:=

In[6]:=
```
elim = Eliminate[eq, {f1[t], Fn2[t]}]
```

Out[6]=
```
g m2 Sin[θ[t]] == Cos[θ[t]]^2 f2[t] + f2[t] Sin[θ[t]]^2 +
    m2 Cos[θ[t]] x0''[t] + m2 R Cos[θ[t]]^2 θ''[t] + m2 R Sin[θ[t]]^2 θ''[t] && i x0''[t] ==
   R^2 (f2[t] + m2 R Sin[θ[t]] θ'[t]^2 - m1 x0''[t] - m2 x0''[t] - m2 R Cos[θ[t]] θ''[t]) && R ≠ 0
```

In[7]:=
```
sol = Solve[elim, {x0''[t], θ''[t]}]
Column[ToMatlab /@ sol[[1, All, 2]], Frame → All]
```

Out[7]=
$$\Big\{\Big\{x0''[t] \to \Big(R^2 \Big(\text{Cos}[\theta[t]]^2\, f2[t] + \text{Cos}[\theta[t]]^3\, f2[t] - g\, m2\, \text{Cos}[\theta[t]]\, \text{Sin}[\theta[t]] + f2[t]\, \text{Sin}[\theta[t]]^2 + \text{Cos}[\theta[t]]\, f2[t]\, \text{Sin}[\theta[t]]^2 + m2\, R\, \text{Cos}[\theta[t]]^2\, \text{Sin}[\theta[t]]\, \theta'[t]^2 + m2\, R\, \text{Sin}[\theta[t]]^3\, \theta'[t]^2\Big)\Big) \Big/ \Big(i\, \text{Cos}[\theta[t]]^2 + m1\, R^2\, \text{Cos}[\theta[t]]^2 + i\, \text{Sin}[\theta[t]]^2 + m1\, R^2\, \text{Sin}[\theta[t]]^2 + m2\, R^2\, \text{Sin}[\theta[t]]^2\Big),\ \theta''[t] \to -\Big(\Big(i\, f2[t] + m1\, R^2\, f2[t] + m2\, R^2\, f2[t] + m2\, R^2\, f2[t]\, \text{Sec}[\theta[t]] - g\, i\, m2\, \text{Sec}[\theta[t]]\, \text{Tan}[\theta[t]] - g\, m1\, m2\, R^2\, \text{Sec}[\theta[t]]\, \text{Tan}[\theta[t]] - g\, m2^2\, R^2\, \text{Sec}[\theta[t]]\, \text{Tan}[\theta[t]] + i\, f2[t]\, \text{Tan}[\theta[t]]^2 + m1\, R^2\, f2[t]\, \text{Tan}[\theta[t]]^2 + m2\, R^2\, f2[t]\, \text{Tan}[\theta[t]]^2 + m2^2\, R^3\, \text{Tan}[\theta[t]]\, \theta'[t]^2\Big) \Big/ \Big(m2\, R\, \Big(i + m1\, R^2 + i\, \text{Tan}[\theta[t]]^2 + m1\, R^2\, \text{Tan}[\theta[t]]^2 + m2\, R^2\, \text{Tan}[\theta[t]]^2\Big)\Big)\Big)\Big\}\Big\}$$

```
R.^2.*(i.*cos(θ(t)).^2+m1.*R.^2.*cos(θ(t)).^2+i.*sin(θ(t)).^2+m1.* ...
  R.^2.*sin(θ(t)).^2+m2.*R.^2.*sin(θ(t)).^2).^(-1).*(cos(θ(t)).^2.* ...
  f2(t)+cos(θ(t)).^3.*f2(t)+(-1).*g.*m2.*cos(θ(t)).*sin(θ(t))+f2(t) ...
  .*sin(θ(t)).^2+cos(θ(t)).*f2(t).*sin(θ(t)).^2+m2.*R.*cos(θ(t)) ...
  .^2.*sin(θ(t)).*Derivative(1)(θ)(t).^2+m2.*R.*sin(θ(t)).^3.* ...
  Derivative(1)(θ)(t).^2);
```

Out[8]=
```
(-1).*m2.^(-1).*R.^(-1).*(i+m1.*R.^2+i.*tan(θ(t)).^2+m1.*R.^2.* ...
  tan(θ(t)).^2+m2.*R.^2.*tan(θ(t)).^2).^(-1).*(i.*f2(t)+m1.*R.^2.* ...
  f2(t)+m2.*R.^2.*f2(t)+m2.*R.^2.*f2(t).*sec(θ(t))+(-1).*g.*i.*m2.* ...
  sec(θ(t)).*tan(θ(t))+(-1).*g.*m1.*m2.*R.^2.*sec(θ(t)).*tan(θ(t))+( ...
  -1).*g.*m2.^2.*R.^2.*sec(θ(t)).*tan(θ(t))+i.*f2(t).*tan(θ(t)).^2+ ...
  m1.*R.^2.*f2(t).*tan(θ(t)).^2+m2.*R.^2.*f2(t).*tan(θ(t)).^2+ ...
  m2.^2.*R.^3.*tan(θ(t)).*Derivative(1)(θ)(t).^2);
```

In[9]:=

Solve the system

Solve for x0''[t]

In[10]:=
```
x0ppsol = First@Simplify@Solve[eq[[3]], x0''[t]]
```

Out[10]=
$$\Big\{x0''[t] \to -\frac{R^2\,(f1[t] - f2[t])}{i}\Big\}$$

In[11]:=
```
Column[eqs2 = Simplify[eq /. x0ppsol], Frame → All] // TraditionalForm
```

Out[11]//TraditionalForm=

$\text{f2}(t)\cos(\theta(t)) = \frac{\text{m2}\,R\left(R\,\text{f1}(t)-R\,\text{f2}(t)-i\,\theta''(t)\cos(\theta(t))+i\,\theta'(t)^2\sin(\theta(t))\right)}{i} + \text{Fn2}(t)\sin(\theta(t))$
$g\,\text{m2} = \text{f2}(t)\sin(\theta(t)) + \text{Fn2}(t)\cos(\theta(t)) + \text{m2}\,R\,\theta''(t)\sin(\theta(t)) + \text{m2}\,R\,\theta'(t)^2\cos(\theta(t))$
True
$\frac{\text{m1}\,R^2\,(\text{f1}(t)-\text{f2}(t))}{i} + \text{f1}(t) + \text{f2}(t)\cos(\theta(t)) = \text{Fn2}(t)\sin(\theta(t))$

Solve for θ''[t]

In[12]:=
```
θppsol = First@Simplify@Solve[eqs2[[1]], θ''[t]]
```

Out[12]=
$$\left\{\theta''[t] \to \frac{\text{m2}\,R^2\,\text{f1}[t]\,\text{Sec}[\theta[t]] - \text{f2}[t]\left(\text{i} + \text{m2}\,R^2\,\text{Sec}[\theta[t]]\right) + \text{i}\,\text{Tan}[\theta[t]]\left(\text{Fn2}[t] + \text{m2}\,R\,\theta'[t]^2\right)}{\text{i}\,\text{m2}\,R}\right\}$$

In[13]:=
```
Column[eqs3 = Simplify[eqs2 /. θppsol], Frame → All] // TraditionalForm
```

Out[13]//TraditionalForm=

True
$g\,\text{m2} = \frac{\sec(\theta(t))\left(\text{m2}\,R\left(R\,\text{f1}(t)\sin(\theta(t))-R\,\text{f2}(t)\sin(\theta(t))+i\,\theta'(t)^2\right)+i\,\text{Fn2}(t)\right)}{i}$
True
$\frac{\text{m1}\,R^2\,(\text{f1}(t)-\text{f2}(t))}{i} + \text{f1}(t) + \text{f2}(t)\cos(\theta(t)) = \text{Fn2}(t)\sin(\theta(t))$

Solve for f1[t]

In[14]:=
```
f1sol = First@Simplify@Solve[eqs2[[4]], f1[t]]
```

Out[14]=
$$\left\{\text{f1}[t] \to \frac{\text{m1}\,\text{R}^2\,\text{f2}[t] - \text{i}\,\text{Cos}[\theta[t]]\,\text{f2}[t] + \text{i}\,\text{Fn2}[t]\,\text{Sin}[\theta[t]]}{\text{i} + \text{m1}\,\text{R}^2}\right\}$$

In[15]:=
```
Column[eqs4 = Simplify[eqs3 /. f1sol], Frame → All] // TraditionalForm
```

Out[15]//TraditionalForm=

True
$g\,\text{m2} = \frac{\text{m2}\,R\left(\left(i+\text{m1}\,R^2\right)\theta'(t)^2\sec(\theta(t))-R\,\text{f2}(t)\left(\sin(\theta(t))+\tan(\theta(t))\right)\right)+\text{Fn2}(t)\left(\left(i+\text{m1}\,R^2\right)\sec(\theta(t))+\text{m2}\,R^2\sin(\theta(t))\tan(\theta(t))\right)}{i+\text{m1}\,R^2}$
True
True

Solve for Fn2[t]

In[16]:=
```
Fn2sol = First@Simplify@Solve[eqs4[[2]], Fn2[t]]
```

Out[16]=
$$\left\{\text{Fn2}[t] \to \frac{\text{m2}\left(\text{R}^2\,\text{f2}[t]\left(\text{Sin}[\theta[t]] + \text{Tan}[\theta[t]]\right) + \left(\text{i} + \text{m1}\,\text{R}^2\right)\left(\text{g} - \text{R}\,\text{Sec}[\theta[t]]\,\theta'[t]^2\right)\right)}{\left(\text{i} + \text{m1}\,\text{R}^2\right)\text{Sec}[\theta[t]] + \text{m2}\,\text{R}^2\,\text{Sin}[\theta[t]]\,\text{Tan}[\theta[t]]}\right\}$$

In[17]:=
```
SetDirectory[NotebookDirectory[]]
Export["Explicitly solving for Matlab.pdf", EvaluationNotebook[]]
```

Out[17]=
```
/home/nathan/olin/fall2016/QEA-BB8/v2
```