In[52]:=
```
SetDirectory[NotebookDirectory[]]
<< "ToMatlab.m"
```

Out[52]= /home/eric/Documents/School/QEA2/Module 3/QEA-BB8/v2

In[47]:=
```
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[48]//TraditionalForm=

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

Out[17]//TraditionalForm=

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

In[49]:=
```
elim = Eliminate[eq, {f1[t], Fn2[t]}]
```

Out[49]=
```
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[69]:=
```
sol = Solve[elim, {x0''[t], θ''[t]}]
Column[ToMatlab /@ sol[[1, All, 2]], Frame → All]
```

Out[69]=
```
{{x0''[t] →
    (R^2 (Cos[θ[t]]^2 f2[t] + Cos[θ[t]]^3 f2[t] - 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]] θ'[t]^2 +
        m2 R Sin[θ[t]]^3 θ'[t]^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), θ''[
    t] →
   -((i f2[t] + m1 R^2 f2[t] + m2 R^2 f2[t] + m2 R^2 f2[t] Sec[θ[t]] - g i m2 Sec[θ[t]] Tan[θ[t]] -
        g m1 m2 R^2 Sec[θ[t]] Tan[θ[t]] - 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]] θ'[t]^2)) /
     (m2 R (i + m1 R^2 + i Tan[θ[t]]^2 + m1 R^2 Tan[θ[t]]^2 + m2 R^2 Tan[θ[t]]^2)))}}
```

```
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[70]=
```
(-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);
```

Out[22]//TraditionalForm=

$$\mathrm{x0}''(t) \to -\left(\left(R^2 \left(-\mathrm{f2}(t)\sin^2(\theta(t)) - \mathrm{f2}(t)\cos^3(\theta(t)) - \mathrm{f2}(t)\cos^2(\theta(t)) - \mathrm{f2}(t)\sin^2(\theta(t))\cos(\theta(t)) - g\,m\sin(\theta(t))\cos(\theta(t)) + m\,R\,\theta'(t)^2\sin^3(\theta(t)) + m\,R\,\theta'(t)^2\sin(\theta(t))\cos^2(\theta(t))\right)\right) \Big/ \left(i\sin^2(\theta(t)) + i\cos^2(\theta(t)) + m\,R^2\cos^2(\theta(t))\right)\right)$$

$$\theta''(t) \to -\left(\left(i\,\mathrm{f2}(t)\tan^2(\theta(t)) + i\,\mathrm{f2}(t) + m\,R^2\,\mathrm{f2}(t)\sec(\theta(t)) + 2\,m\,R^2\,\mathrm{f2}(t) - g\,i\,m\tan(\theta(t))\sec(\theta(t)) - m^2\,R^3\,\theta'(t)^2\tan(\theta(t))\right)\right) \Big/ \left(m\,R\left(i\tan^2(\theta(t)) + i + m\,R^2\right)\right)$$

Solve the system

Solve for x0''[t]

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

$$\left\{\text{x0}''[\text{t}] \to -\frac{\text{R}^2 \left(\text{f1}[\text{t}] - \text{f2}[\text{t}]\right)}{\text{i}}\right\}$$

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

$\text{f2}(t)\cos(\theta(t)) = \frac{m\,R\left(R\,\text{f1}(t) - R\,\text{f2}(t) - i\,\theta''(t)\cos(\theta(t)) + i\,\theta'(t)^2\sin(\theta(t))\right)}{i} + \text{Fn2}(t)\sin(\theta(t))$
$g\,m = \text{f2}(t)\sin(\theta(t)) + \text{Fn2}(t)\cos(\theta(t)) + m\,R\,\theta''(t)\sin(\theta(t)) + m\,R\,\theta'(t)^2\cos(\theta(t))$
True
$\frac{m\,R^2\,(\text{f1}(t) - \text{f2}(t))}{i} + \text{f1}(t) + \text{f2}(t)\cos(\theta(t)) + \text{Fn2}(t)\sin(\theta(t)) = 0$

Solve for θ''[t]

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

$$\left\{\theta''[\text{t}] \to \frac{1}{\text{i}\,\text{m}\,\text{R}}\left(\text{m}\,\text{R}^2\,\text{f1}[\text{t}]\,\text{Sec}[\theta[\text{t}]] - \text{f2}[\text{t}]\left(\text{i} + \text{m}\,\text{R}^2\,\text{Sec}[\theta[\text{t}]]\right) + \text{i}\,\text{Tan}[\theta[\text{t}]]\left(\text{Fn2}[\text{t}] + \text{m}\,\text{R}\,\theta'[\text{t}]^2\right)\right)\right\}$$

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

True
$g\,m = \frac{\sec(\theta(t))\left(m\,R\left(R\,\text{f1}(t)\sin(\theta(t)) - R\,\text{f2}(t)\sin(\theta(t)) + i\,\theta'(t)^2\right) + i\,\text{Fn2}(t)\right)}{i}$
True
$\frac{m\,R^2\,(\text{f1}(t) - \text{f2}(t))}{i} + \text{f1}(t) + \text{f2}(t)\cos(\theta(t)) + \text{Fn2}(t)\sin(\theta(t)) = 0$

Solve for f1[t]

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

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

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

True
$g\,m = \sec(\theta(t))\left(\frac{m\,R\left(-R\,\text{f2}(t)\sin(\theta(t))\left(\cos(\theta(t)) + 1\right) - R\,\text{Fn2}(t)\sin^2(\theta(t)) + \left(i + m\,R^2\right)\theta'(t)^2\right)}{i + m\,R^2} + \text{Fn2}(t)\right)$
True
True

Solve for Fn2[t]

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

$$\left\{\text{Fn2}[t] \to \left(m \left(R^2\, f2[t] \left(2 \sin[\theta[t]] + \sin[2\theta[t]]\right) + 2\left(i + m R^2\right)\left(g \cos[\theta[t]] - R\,\theta'[t]^2\right)\right)\right) \Big/ \left(2\, i + m R^2 + m R^2 \cos[2\theta[t]]\right)\right\}$$

In[71]:=
```
SetDirectory[NotebookDirectory[]]
Export["Explicitly solving for Matlab.pdf", EvaluationNotebook[]]
```

Out[71]= /home/eric/Documents/School/QEA2/Module 3/QEA-BB8/v2