In[16]:=
```
eq = {
   m (x0''[t] + R (θ''[t] Cos[θ[t]] - θ'[t]^2 Sin[θ[t]])) ==
    -f2[t] Cos[θ[t]] + Fn2[t] Sin[θ[t]],
   m R (-θ''[t] Sin[θ[t]] - θ'[t]^2 Cos[θ[t]]) == f2[t] Sin[θ[t]] + Fn2[t] Cos[θ[t]] - m g,
   f2[t] - f1[t] == (x0''[t])/R^2 i,
   f1[t] + f2[t] Cos[θ[t]] + Fn2[t] Sin[θ[t]] == m x0''[t]
  };
Column[Simplify@eq, Frame → All] // TraditionalForm
```

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[19]:=
```
elim = Eliminate[eq, {f1[t], Fn2[t]}]
```

Out[19]=
```
g m Sin[θ[t]] == Cos[θ[t]]^2 f2[t] + f2[t] Sin[θ[t]]^2 +
    m Cos[θ[t]] x0''[t] + m R Cos[θ[t]]^2 θ''[t] + m R Sin[θ[t]]^2 θ''[t] &&
 i x0''[t] == R^2 (f2[t] + 2 Cos[θ[t]] f2[t] - m R Sin[θ[t]] θ'[t]^2 + m R Cos[θ[t]] θ''[t]) && R ≠ 0
```

In[22]:=
```
Grid@Solve[elim, {x0''[t], θ''[t]}] // TraditionalForm
```

Out[22]//TraditionalForm=

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

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

Solve the system

Solve for x0”[t]

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

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

```
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]]
```

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

```
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]]
```

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

```
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]]
```

$$\left\{\text{Fn2}[t] \to \frac{\text{m}\left(\text{R}^2\ \text{f2}[t]\ \left(2\,\text{Sin}[\theta[t]] + \text{Sin}[2\,\theta[t]]\right) + 2\ \left(\text{i} + \text{m R}^2\right)\ \left(\text{g Cos}[\theta[t]] - \text{R}\,\theta'[t]^2\right)\right)}{2\,\text{i} + \text{m R}^2 + \text{m R}^2\ \text{Cos}[2\,\theta[t]]}\right\}$$

In[41]:=
```
SetDirectory[NotebookDirectory[]]
Export["Explicitly solving for Matlab.pdf", EvaluationNotebook[]]
```

Out[41]= /home/eric/Documents/School/QEA2/Module 3/QEA-BB8/v2