```
(%i16) kill(all);
```

(%o0) *done*

1 Lagrangian (4)

```
(%i1) depends([r,phi,rdot,phidot], t);
```

(%o1) [r(t), phi(t), rdot(t), phidot(t)]

```
(%i2) Lg: 1/2*m*(rdot^2+r^2*phidot^2)+x^2/r-(x^2-1)*L^2/(2*m*r^2);
```

(%o2) $$\frac{(1-x^2)L^2}{2\,m\,r^2}+\frac{x^2}{r}+\frac{m\,(rdot^2+phidot^2\,r^2)}{2}$$

2 Lagrange equations (5-7)

```
(%i3) diff(Lg,r) = diff(diff(Lg,rdot),t);
```

(%o3) $$-\frac{(1-x^2)L^2}{m\,r^3}-\frac{x^2}{r^2}+m\,phidot^2\,r=m\left(\frac{d}{d\,t}\,rdot\right)$$

```
(%i4) diff(Lg,phi) = diff(diff(Lg,phidot),t);
```

(%o4) $$0=2\,m\,phidot\,r\left(\frac{d}{d\,t}\,r\right)+m\left(\frac{d}{d\,t}\,phidot\right)r^2$$

3 Time integration

```
(%i11) t: 1/x*m*alpha^2/L*'integrate(1/((1+epsilon*cos(phi1))^2), phi1);
```

(%o11) $$\frac{\alpha^2\,m\int\frac{1}{(\varepsilon\cos(phi1)+1)^2}\,d\,phi1}{x\,L}$$

```
(%i14) t1 :ev(t, integrate);
Is  ε^2-1.0  positive or negative? n;
```

(%o14)

$$\frac{2\,\alpha^2\,m\left(\frac{\operatorname{atan}\left(\frac{(2\,\varepsilon-2)\sin(phi1)}{2\sqrt{1-\varepsilon^2}\,(\cos(phi1)+1)}\right)}{\sqrt{1-\varepsilon^2}\,(\varepsilon^2-1)}-\frac{\varepsilon\sin(phi1)}{(\cos(phi1)+1)\left(\frac{(\varepsilon^3-\varepsilon^2-\varepsilon+1)\sin(phi1)^2}{(\cos(phi1)+1)^2}-\varepsilon^3-\varepsilon^2+\varepsilon+1\right)}\right)}{x\,L}$$

```
(%i15) fortran(t1);
     2*alpha**2*m*(atan((2*epsilon-2)*sin(phi1)/(sqrt(1-epsilon**2)*(co
    1   s(phi1)+1))/2.0E+0)/(sqrt(1-epsilon**2)*(epsilon**2-1))-epsilon
    2   *sin(phi1)/((cos(phi1)+1)*((epsilon**3-epsilon**2-epsilon+1)*si
    3   n(phi1)**2/(cos(phi1)+1)**2-epsilon**3-epsilon**2+epsilon+1)))/
    4   (x*L)
(%o15) done
```