```
ln[1] = q = q0 * Exp[I * (k * x + w * t)];
     qjn = q0 * Exp[I * (k * xj + w * tn)];
     qjp1n = q0 * Exp[I * (k * (xj + dx) + w * tn)];
     qjp1F = Simplify[qjp1n/(qjn)];
     qjp2n = q0 * Exp[I * (k * (xj + 2 * dx) + w * tn)];
     qjp2F = Simplify[qjp2n/(qjn)];
     qjm1n = q0 * Exp[I * (k * (xj - dx) + w * tn)];
     qjm1F = Simplify[qjm1n/(qjn)];
     qjm2n = q0 * Exp[I * (k * (xj - 2 * dx) + w * tn)];
     qjm2F = Simplify[qjm2n/(qjn)];
     wAp = -U * k - \frac{\sqrt{3} k \sqrt{g H (3 + H^2 k^2)}}{3 + H^2 k^2};
     wAm = - U * k + \frac{\sqrt{3} k \sqrt{g H (3 + H^2 k^2)}}{3 + H^2 k^2};
ln[13]:= Dx = FullSimplify[(qjp1F - qjm1F) / (2 * dx)];
     Dxerr = Series[Dx - (I * k), {dx, 0, 4}];
     DxDx = FullSimplify[(qjp1F - 2 + qjm1F) / dx^2];
      \texttt{DxDxerr} = \texttt{Series}[\texttt{DxDx} - (-k * k), \{dx, 0, 4\}]; 
     DxDxDx = FullSimplify[(qjp2F - 2 qjp1F + 2 * qjm1F - qjm2F) / (2 * dx * dx * dx)];
     DxDxDxerr = Series[DxDxDx - (-I*k*k*k), {dx, 0, 4}];
     Text[Row[{"Dx || ", Dx}]]
     Text[Row[{"Dx || ", TeXForm[Dx]}]]
     Text[Row[{"Dx error || ", TeXForm[Dxerr]}]]
     Text[Row[{"Dx error || ", Dxerr}]]
     Text[" "]
     Text[Row[{"DxDx || ", DxDx}]]
     Text[Row[{"DxDx || ", TeXForm[DxDx]}]]
     Text[Row[{"DxDx error || ", TeXForm[DxDxerr]}]]
     Text[Row[{"DxDx error ||
                                      ", DxDxerr}]]
     Text[" "]
     Text[Row[{"DxDxDx || ", DxDxDx}]]
     Text[Row[{"DxDxDx || ", TeXForm[DxDxDx]}]]
     Text[Row[{"DxDxDx error || ", TeXForm[DxDxDxerr]}]]
     Text[Row[{"DxDxDx error || ", DxDxDxerr}]]
     Text[" "]
Out[19]= Dx \mid \mid \frac{i \sin[dx k]}{dx}
Out[20]= Dx \parallel \frac{\sin (\text{text}\{dx\} k)}{\text{text}\{dx\}}
```

 $\label{eq:output} \begin{tabular}{ll} Output = 0 \end{tabular} Output = 0 \end{tabular} Dx error & -\frac{1}{6} i \text{ $k^3+\frac{1}{120}$ i $$ \text{$k^5+O\left(\frac{4x}^5\right)^2$ right)} $} \\$

$$\mbox{Out} \mbox{[22]=} \ \ Dx \ error \ \ || \ \ -\frac{1}{6} \ i \ k^3 \ dx^2 + \frac{1}{120} \ i \ k^5 \ dx^4 + O[dx]^5$$

Out[23]=

$$\text{Out} [24] = \begin{array}{ccc} DxDx & || & \frac{2\left(-1 + Cos[dx \, k]\right)}{dx^2} \end{array}$$

 $\label{eq:output} \begin{tabular}{ll} $\operatorname{Out}[25]=$ $\operatorname{DxDx} & \| \operatorname{frac}\{2 (\cos (\operatorname{text}\{dx\} k)-1)\}(\operatorname{text}\{dx\}^2) \end{tabular}$

 $\label{eq:continuous} \begin{tabular}{ll} Out[26]= DxDx error & $| \frac{dx}^2 k^4}{12}-\frac{dx}^4 k^6}{360}+O\left(\frac{dx}^5\right)-\frac{dx}^4 k^6} & $| A^6|^2 + O\left(\frac{dx}^5\right)-\frac{dx}^4 k^6} & $| A^6|^2 + O\left(\frac{dx}^5\right)-\frac{dx}^6 k^6} & $| A^6|^2 + O\left(\frac{dx}^6\right)-\frac{dx}^6 k^6} & $| A^6|^2 + O\left(\frac{dx}^6\right)-\frac{dx}^6 k^6} & $| A^6|^2 + O\left(\frac{dx}^6\right)-\frac{dx}^6 k$

$$\text{Out} \text{[27]= } DxDx \; error \; \mid \mid \; \; \frac{k^4 \, dx^2}{12} - \frac{k^6 \, dx^4}{360} + O[dx]^5$$

Out[28]=

$$\begin{array}{ll} \text{Out[29]=} & DxDxDx & || & -\frac{4\,i\,\text{Sin}\left[\frac{dx\,k}{2}\right]^2\text{Sin}[dx\,k]}{dx^3} \end{array}$$

 $\label{eq:outside} Outside DxDxDx \parallel -\frac{4 i \sin^2\left(\frac{text{dx} k}{2}\right) \sin\left(\frac{text{dx} k}{3}\right)}{\left(\frac{text{dx} k}{3}\right)} = DxDxDx \parallel -\frac{4 i \sin^2\left(\frac{text{dx} k}{3}\right)}{\left(\frac{$

 $\label{eq:output} \begin{tabular}{ll} Output Part of the content of the content$

Out[32]=
$$DxDxDx \ error \ || \ \frac{1}{4} \, \dot{\imath} \, k^5 \, dx^2 - \frac{1}{40} \, \dot{\imath} \, k^7 \, dx^4 + O[dx]^5$$

Out[33]=

```
\ln |34| = \text{upsspatderivs} = -\left(g + H + Dx + n + U + H + Dx + v - H^3 / 3 + U + Dx Dx Dx Dx + v\right);
      upsspatderivsLHS =
         H*v - H^3/3*DxDx /. v \rightarrow 1 /. Cos[dxk] - 1 \rightarrow -2*Sin[dxk/2]^2;
      upsspatderivs = upsspatderivs /. v \rightarrow 1 /. n \rightarrow 0;
      upsspatderivsu = Simplify[upsspatderivsu / upsspatderivsLHS];
      upsspatderivsn = upsspatderivs /. n \rightarrow 1 /. v \rightarrow 0;
      upsspatderivsn = Simplify[upsspatderivsn / upsspatderivsLHS];
      vph = Simplify[((1 + qjp1F) vnp1 + (1 + qjp1F) v)/4];
      vmh = Simplify[((1 + qjm1F) vnp1 + (1 + qjm1F) v)/4];
      hph = n * (qjp1F + 1) / 2 - dt / (2 * dx) * (H * (qjp1F - 1) * v + U * n * (qjp1F - 1));
      hmh = n * (1 + qjm1F) / 2 - dt / (2 * dx) * (H * (1 - qjm1F) * v + U * n * (1 - qjm1F));
      LWFlux = n - dt / dx * (H * (vph - vmh) + U * (hph - hmh)) /.
          vnp1 → vnm1 + 2 * dt * (upsspatderivsu * v + upsspatderivsn * n);
      LWFluxun = FullSimplify[LWFlux /. v \rightarrow 1 /. vnm1 \rightarrow 0 /. n \rightarrow 0];
       \label{eq:lwflux}  \mbox{LWFluxunm1 = FullSimplify[LWFlux /. } \mbox{$v \to 0$ /. } \mbox{$v nm1 \to 1$ /. } \mbox{$n \to 0$];} 
      FullSimplify \left[ e^{-i dx k} \left( -1 + e^{2 i dx k} \right) \right];
      FullSimplify \left[ e^{-i dx k} \left( -1 + e^{i dx k} \right)^{2} \right];
      LWFluxn =
          \texttt{Simplify[LWFlux /. v} \rightarrow \texttt{0 /. vnm1} \rightarrow \texttt{0 /. n} \rightarrow \texttt{1] /. } \texttt{e}^{-i \, dx \, k} \left(-1 + e^{2 \, i \, dx \, k}\right) \rightarrow \texttt{0 /. n} 
             2 * I * Sin[k * dx] /. e^{-i dx k} (-1 + e^{i dx k})^{2} \rightarrow 2 (-2 * Sin[dx k/2]^{2});
      Emat = {{LWFluxn , LWFluxun }, {2 * dt * upsspatderivsn, 2 * dt * upsspatderivsu}};
      EmatF = Emat + Exp[-I * (wAp) * dt] \{ \{0, LWFluxunm1\}, \{0, 1\} \};
      Ematerr =
         Series [ EmatF - Exp[I * wAp * dt] * IdentityMatrix[2] , {dx, 0, 2}, {dt, 0, 2}];
      EmatEig = Eigenvalues[Emat + Exp[-I * (wAp) * dt] \{\{0, LWFluxunm1\}, \{0, 1\}\}\};
      EmatEig = Series [ wAp - Log [ EmatEig ] / (I * dt), \{dx, 0, 2\}, \{dt, 0, 2\}];
```

```
In[55]:= Text[Row[{"E00 ||
                                                                                                                                                                                                                                                                 ", LWFluxn]]]
                                                  Text[Row[{"E00
                                                                                                                                                                                                                                                                  ", TeXForm[LWFluxn]}]]
                                               Text[" "]
                                                 Text[Row[{"E01
                                                                                                                                                                                                          || ", LWFluxun}]]
                                                 Text[Row[{"E01
                                                                                                                                                                                                                                                                 ", TeXForm[LWFluxun]}]]
                                                 Text[" "]
                                                 Text[Row[{"E03
                                                                                                                                                                                                                \Pi
                                                                                                                                                                                                                                                                 ", LWFluxunm1}]]
                                                 Text[Row[{"E03
                                                                                                                                                                                                                                                              ", TeXForm[LWFluxunm1]}]]
                                                 Text[" "]
                                                 Text[Row[{"E10 ||
                                                                                                                                                                                                                                                                 ", upsspatderivsn}]]
                                                 Text[Row[{"E10
                                                                                                                                                                                                                                                     ", TeXForm[upsspatderivsn]}]]
                                                 Text[" "]
                                                 Text[Row[{"E11 || ", upsspatderivsu}]]
                                                  Text[Row[{"E11 ||
                                                                                                                                                                                                                                                                  ", TeXForm[upsspatderivsu]}]]
                                                 Text[" "]
                                                 Text[Row[{"EmatEig ||
                                                                                                                                                                                                                                                                                                       ", EmatEig }]]
                                                 Text[Row[{"EmatEig ||
                                                                                                                                                                                                                                                                                                         ", TeXForm[EmatEig]}]]
                                                 Text[" "]
                                                 Text[Row[{"Ematerr ||
                                                                                                                                                                                                                                                                                                       ", Ematerr }]]
                                                  Text[Row[{"Ematerr ||
                                                                                                                                                                                                                                                                                               ", TeXForm[Ematerr]}]]
\text{Out} [55] = \ E00 \ || \ \frac{1}{2} \left( 2 + dt^2 \left( -\frac{4 \, \text{U}^2 \, \text{Sin} \left[ \frac{dx \, k}{2} \right]^2}{dx^2} + \frac{3 \left( -1 + e^{2 \, i \, dx \, k} \right) g \, H}{6 \, dx^2 + 8 \, H^2 \, \text{Sin} \left[ \frac{dx \, k}{2} \right]^2} \right) - \frac{2 \, i \, dt \, U \, \text{Sin} [dx \, k]}{dx} - \frac{3 \, i \, dt^2 \, e^{-i \, dx \, k} \, g \, H \, \text{Sin} [dx \, k]}{3 \, dx^2 + 4 \, H^2 \, \text{Sin} \left[ \frac{dx \, k}{2} \right]^2} \right)
\label{eq:outs6} \begin{tabular}{ll} $$ Outs6= E00 & frac{1}{2} \left( \frac{dx}^2 \left( \frac{dy^2 \sin^2\theta (\frac{dx}^2 + \frac{dy^2}{2})}{\frac{dy^2 \sin^2\theta (\frac{dx}^2 + \frac{dy^2}{2})}{\frac{dy^2 \sin^2\theta (\frac{dy}{2})}{\frac{dy^2 \sin^2\theta (\frac{dy}{2})
                                                                                          g H \left(-1+e^{2 i \text{dx} k}\right) (\frac{\text{dx}^2+8 H^2 \sin ^2\\eft(\frac{\text{dx}}{dx})
                                                                                          k}{2}\right)-\frac{3 i \text{ } k}{2}\right)-\frac{3 i \text{ } k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k} \cdot \frac{4 k}{3 i \text{ } k}} = \frac{4 k}{3 i \text{ } k}} =
                                                                                          H^2 \sin^2\left(\frac{dx}{k}^2\right) - \frac{1}{2} \cdot \frac{dx}{dx} = \frac{1}{2} \cdot \frac{dx}{dx} + \frac{1}{2} \cdot \frac{1}{2
Out[57]=
Out[59]= E01 ||
                                                              \label{eq:linear_continuous_series} $$ \frac{dt} H (\text{dt} U (2 \cos (\text{dx} k) + \cos (2 \text{dx} k) - 3) - i \text{dx} \sin (\text{dx} k))}{2 \text{dx}^2} $$
Out[60]=
Out[61]= E03 \mid \mid -\frac{i \operatorname{dt} H \operatorname{Sin}[\operatorname{dx} k]}{2 \operatorname{dx}}
\label{eq:outf62} \begin{tabular}{ll} $ Outf62] = E03 & $|| -\frac{i \cdot k}{dt} H \sin (\cdot k)} & $| 2 \cdot k \\ \hline \end{tabular} 
Out[63]=
Out[64]= E10 || -\frac{3 i dx g Sin[dx k]}{3 dx^2 + 4 H^2 Sin \left[\frac{dx k}{2}\right]^2}
```

Out[68]= E11 || $-\frac{i U \sin (\text{text}\{dx\} k)}{\text{text}\{dx\}}$

$$\begin{array}{l} \text{Cuttrops} & \text{EmatEig} \ \| \ \left\{ -\frac{3 \left[\sqrt{3} \ k \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \right] + i \sqrt{3} \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \right. \\ + \\ \frac{1}{2 \, (3 + \text{H}^2 \, k^2)^2} i \left(9 \, g \, \text{H} \, k^2 + 3 \, g \, \text{H}^2 \, k^4 + 3 \, i \, k \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, - \\ 6 \, \sqrt{3} \, \, k^2 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} - 2 \, \sqrt{3} \, \, \, \text{H}^2 \, k^3 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} - \\ 6 \, i \, \sqrt{3} \, \, k \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} - 2 \, i \, \sqrt{3} \, \, \, \text{H}^2 \, k^3 \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} \right) \, dt \, + \\ \frac{1}{16 \, g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \left[\left(5 \, 4 \, \sqrt{3} \, \, g^2 \, \text{H}^2 \, k^3 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, + 48 \, i \, \sqrt{3} \, \, g^2 \, \text{H}^2 \, k^2 \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} \right. \\ - 324 \, g^2 \, \text{H}^2 \, k^3 \, \text{U} - 108 \, g^2 \, \text{H}^2 \, k^2 \, \text{U} - 144 \, i \, g \, \text{H}^2 \, k^2 \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U} + \\ 108 \, \sqrt{3} \, \, g \, \text{H} \, k^3 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^2 + 36 \, \sqrt{3} \, \, g \, \text{H}^3 \, k^4 \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^2 + \\ 81 \, g \, \text{H} \, k^3 \, \sqrt{3} \, g \, \text{H} \, k^3 \, \text{U}^3 \, + 9 \, g \, \text{H}^3 \, k^7 \, \text{U}^3 + 3 \, i \, k^2 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^2 + \\ i \, H^2 \, k^4 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 + 3 \, i \, k^2 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 + \\ i \, H^2 \, k^4 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \sqrt{-g \, \text{H} \, k^2 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 + \frac{1}{422 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 \right)} + \\ \left(i \, \left(24 \, \sqrt{3} \, \, g \, \text{H} \, k^4 + 6 \, \sqrt{3} \, \, g \, \text{H}^3 \, k^6 - 3 \, k^4 \, \sqrt{g \, \text{H} \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 + \frac{1}{422 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 + \frac{1}{422 \, (3 + \text{H}^2 \, k^2)} \, \, \text{U}^3 \right) \right) \right) \right) \right) \\ \left(g \, \left(-12 \, - 4 \, \text{H}^2 \, k^2 \right) \, \sqrt{-g \, \text{H}^2 \, \left(3 \, + \text{H}^2 \, k^2 \right)} \, \,$$

$$\frac{1}{11664(3+115^2k)^3} \sqrt{-gHE(3+115^2k)} \left(57024 i \sqrt{3} g^2 H^2 k^6 + 33264 i \sqrt{3} g^2 H^4 k^8 + 4752 i \sqrt{3} g^2 H^6 k^{10} - 17496 \sqrt{3} gHk^5 \sqrt{gH(3+H^2k^2)} - gHk^2(3+H^2k^2) - 4374 \sqrt{3} gH^3 k^8 \sqrt{gH(3+H^2k^2)} \sqrt{-gHk^2(3+H^2k^2)} - 168480 i gHk^6 \sqrt{gH(3+H^2k^2)} U - 106650 i gH^3 k^8 \sqrt{gH(3+H^2k^2)} U - 16830 i gH^5 k^{10} \sqrt{gH(3+H^2k^2)} U + 170586 gHk^2 \sqrt{-gHk^2(3+H^2k^2)} U + 109350 gH^5 k^{10} \sqrt{gH(3+H^2k^2)} U + 17496 gH^5 k^{10} \sqrt{gH(3+H^2k^2)} U + 159894 i \sqrt{3} gH^6 k^2 + 161676 i \sqrt{3} gH^3 k^3 U^2 + 54486 i \sqrt{3} gH^5 k^{10} U^2 + 6120 i \sqrt{3} gH^7 k^{12} U^2 - 52488 \sqrt{3} k^3 \sqrt{gH(3+H^2k^2)} U - 5832 \sqrt{3} H^4 k^9 \sqrt{gH(3+H^2k^2)} U^2 - 34992 \sqrt{3} H^2 k^2 U^2 - 52488 \sqrt{3} k^3 \sqrt{gH(3+H^2k^2)} U^2 - 5832 \sqrt{3} H^4 k^9 \sqrt{gH(3+H^2k^2)} U^3 - 9675 i H^4 k^{10} \sqrt{gH(3+H^2k^2)} U^3 - 1071 i H^6 k^{12} \sqrt{gH(3+H^2k^2)} U^3 + 32805 k^3 \sqrt{-gHk^2(3+H^2k^2)} U^3 - 1071 i H^6 k^{12} \sqrt{gH(3+H^2k^2)} U^3 + 32805 k^3 \sqrt{-gHk^2(3+H^2k^2)} U^3 + 1215 H^6 k^{11} \sqrt{-gHk^2(3+H^2k^2)} U^3 + 1296 i \sqrt{3} k^6 U^4 - 1728 i \sqrt{3} H^2 k^{12} U^3 + 1215 H^6 k^{11} \sqrt{-gHk^2(3+H^2k^2)} U^3 - 1296 i \sqrt{3} k^6 U^4 - 1728 i \sqrt{3} H^2 k^{12} U^3 + 1215 H^6 k^{11} \sqrt{-gHk^2(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U + 6i \sqrt{3} k \sqrt{-gHk^2(3+H^2k^2)} U + 6i \sqrt{3} k \sqrt{-gHk^2(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U + 6i \sqrt{3} k \sqrt{-gHk^2(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U + 6i \sqrt{3} k \sqrt{-gHk^2(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U + 6i \sqrt{3} k \sqrt{-gHk^2(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U + 6i \sqrt{3} gHk^3 \sqrt{gH(3+H^2k^2)} U - 2\sqrt{3} H^2 k^4 \sqrt{gH(3+H^2k^2)} U - 2Hk^2 (3+H^2k^2) U + 108 \sqrt{3} gHk^3 \sqrt{gH(3+H^2k^2)} U - 24 \delta i \sqrt{3} gHk^3 \sqrt{gH(3+H^2k^2)} U - gHk^2 (3+H^2k^2) U + 108 \sqrt{3} gHk^3 \sqrt{gH(3+H^2k^2)} U - 24 \delta i \sqrt{3} gHk^3 \sqrt{gH(3+H^2k^2)} U - 94 k^2 \sqrt{gHk^2(3+H^2k^2)} U - 94 k^2 \sqrt{gHk^2(3+H$$

 $27 i k^{3} \sqrt{-g H k^{2} (3 + H^{2} k^{2})} U + 9 i H^{2} k^{5} \sqrt{-g H k^{2} (3 + H^{2} k^{2})} U \bigg) \bigg) \bigg/$ $\left(9 \left(-12 -4 \ H^2 \ k^2\right) \sqrt{-g \ H \ k^2 \left(3 + H^2 \ k^2\right)} \ \right) \right) + \frac{1}{432 \left(3 + H^2 \ k^2\right)^2 \sqrt{-g \ H \ k^2 \left(3 + H^2 \ k^2\right)}}$ $\left(360\,g\,H\,k^{5}\,\sqrt{g\,H\left(3+H^{2}\,k^{2}\right)}\right. + 90\,g\,H^{3}\,k^{7}\,\sqrt{g\,H\left(3+H^{2}\,k^{2}\right)}\right. \\ \left. - 648\,\emph{i}\,g\,H\,k^{4}\,\sqrt{-g\,H\,k^{2}\left(3+H^{2}\,k^{2}\right)}\right. \\ \left. - 648\,\emph{i}\,g\,H\,k^{2}\,\sqrt{-g\,H\,k^{2}\left(3+H^{2}\,k^{2}\right)}\right. \\ \left. - 648\,\emph{i}\,g\,H\,k^{2}\,\sqrt{-g\,H\,k^{2}\left(3+H^{2}\,k^{2}\right)}\right. \\ \left. - 648\,\emph{i}\,g\,H\,k^{2}\,M\,k^{2}\,H\,k^{2}\,M\,k^{2}\,M\,k^{2}\,H\,k^{2}\,M\,k^{2$ $162 i g H^3 k^6 \sqrt{-g H k^2 (3 + H^2 k^2)} - 1548 \sqrt{3} g H k^5 U - 1008 \sqrt{3} g H^3 k^7 U 164\sqrt{3} \text{ g H}^5 \text{ k}^9 \text{ U} + 216 i \sqrt{3} \text{ k}^4 \sqrt{\text{g H}(3 + \text{H}^2 \text{k}^2)} \sqrt{-\text{g H k}^2 (3 + \text{H}^2 \text{k}^2)} \text{ U} +$ 72 $i\sqrt{3}$ H² k⁶ $\sqrt{g$ H (3 + H² k²) $\sqrt{-g}$ H k² (3 + H² k²) U + 279 k⁵ \sqrt{g} H (3 + H² k²) U² + $186 \,\mathrm{H}^2\,\mathrm{k}^7\,\sqrt{\mathrm{g}\,\mathrm{H}\,(3+\mathrm{H}^2\,\mathrm{k}^2)}\,\,\mathrm{U}^2 + 31\,\mathrm{H}^4\,\mathrm{k}^9\,\sqrt{\mathrm{g}\,\mathrm{H}\,(3+\mathrm{H}^2\,\mathrm{k}^2)}\,\,\mathrm{U}^2 - 891\,i\,\mathrm{k}^4\,\sqrt{-\mathrm{g}\,\mathrm{H}\,\mathrm{k}^2\,(3+\mathrm{H}^2\,\mathrm{k}^2)}$ $U^2 - 594 i H^2 k^6 \sqrt{-g H k^2 (3 + H^2 k^2)} U^2 - 99 i H^4 k^8 \sqrt{-g H k^2 (3 + H^2 k^2)} U^2 dt +$ $\frac{1}{^{11\,664\,\left(3+H^2\,k^2\right)^3}\sqrt{^{-g\,H\,k^2\,\left(3+H^2\,k^2\right)}}}\bigg(-57\,024\,\emph{i}\,\,\sqrt{3}\,\,g^2\,H^2\,k^6-33\,264\,\emph{i}\,\,\sqrt{3}\,\,g^2\,H^4\,k^8 4752 i \sqrt{3} g^2 H^6 k^{10} - 17496 \sqrt{3} g H k^5 \sqrt{g H (3 + H^2 k^2)} \sqrt{-g H k^2 (3 + H^2 k^2)} 4374\sqrt{3}$ g H³ k⁷ $\sqrt{g$ H (3 + H² k²) $\sqrt{-g}$ H k² (3 + H² k²) + 168 480 i g H k⁶ \sqrt{g} H (3 + H² k²) U + $106650 i g H^3 k^8 \sqrt{g H (3 + H^2 k^2)} U + 16830 i g H^5 k^{10} \sqrt{g H (3 + H^2 k^2)} U +$ $170\,586\,\mathrm{g\,H\,k^5}\,\sqrt{-\mathrm{g\,H\,k^2\,(3+H^2\,k^2)}}\,\,\mathrm{U}+109\,350\,\mathrm{g\,H^3\,k^7}\,\sqrt{-\mathrm{g\,H\,k^2\,(3+H^2\,k^2)}}\,\,\mathrm{U}+$ $17496 \text{ g H}^5 \text{ k}^9 \sqrt{-\text{g H k}^2 (3 + \text{H}^2 \text{ k}^2)} \text{ U} - 159894 i \sqrt{3} \text{ g H k}^6 \text{ U}^2 - 161676 i \sqrt{3} \text{ g H}^3 \text{ k}^8 \text{ U}^2 54486 i \sqrt{3} g H^5 k^{10} U^2 - 6120 i \sqrt{3} g H^7 k^{12} U^2 - 52488 \sqrt{3} k^5 \sqrt{g H (3 + H^2 k^2)}$ $\sqrt{-g H k^2 (3 + H^2 k^2)} U^2 - 34992 \sqrt{3} H^2 k^7 \sqrt{g H (3 + H^2 k^2)} \sqrt{-g H k^2 (3 + H^2 k^2)} U^2 5832\sqrt{3}$ H⁴ k⁹ $\sqrt{g$ H (3 + H² k²) $\sqrt{-g}$ H k² (3 + H² k²) U² + 29 241 i k⁶ \sqrt{g} H (3 + H² k²) U³ + 29 133 i H² k⁸ $\sqrt{g$ H (3 + H² k²) U³ + 9675 i H⁴ k¹⁰ $\sqrt{g$ H (3 + H² k²) U³ + $1071 \, i \, H^6 \, k^{12} \, \sqrt{g \, H \, \big(3 + H^2 \, k^2 \big)} \, \, U^3 + 32 \, 805 \, k^5 \, \sqrt{-g \, H \, k^2 \, \big(3 + H^2 \, k^2 \big)} \, \, U^3 + 22 \, k^2 \,$ $32\,805\,H^2\,k^7\,\sqrt{-g\,H\,k^2\,(3+H^2\,k^2)}\,U^3+10\,935\,H^4\,k^9\,\sqrt{-g\,H\,k^2\,(3+H^2\,k^2)}\,U^3+$ $1215\,H^6\,k^{11}\,\sqrt{-g\,H\,k^2\left(3+H^2\,k^2\right)}\,\,U^3+1296\,i\,\sqrt{3}\,\,k^6\,U^4+1728\,i\,\sqrt{3}\,\,H^2\,k^8\,U^4+$ $864 i \sqrt{3} H^4 k^{10} U^4 + 192 i \sqrt{3} H^6 k^{12} U^4 + 16 i \sqrt{3} H^8 k^{14} U^4 + O[dt]^3 dx^2 + O[dx]^3$

 $\begin{tabular}{ll} $\operatorname{EmatEig} & \| \left(\left(\frac{3 \left(\sqrt{3} \right) \left(\frac{3} \right) \left(\frac{3} \left(\frac{3} \right) \left(\frac{3} \right$

 $\label{eq:hamiltonian} H \ k^2 \left(H^2 \ k^2 + 3\right) U^3 \ k^4 + 18 \ i \ \left(H^2 \ k^2$ U^2 k^4+81 g H U^3 k^3+108 \sqrt{3} g H \sqrt{g H \left(H^2 k^2+3\right)} U^2 k^3-324 g^2 H^2 $U k^3+54 \sqrt{3} g^2 H^2 \sqrt{g} H \left(\frac{h^2 k^2+3\right)} k^3+3 i \sqrt{g} H \left(\frac{h^2 k^2+3\right)}$ $\$ \\sqrt{-g H k^2 \left(H^2 k^2+3\right)} U^3 k^2+54 i \\sqrt{3} g H \\sqrt{-g H k^2 \left(H^2 k^2+3\right)} $\label{eq:continuity} $$U^2 k^2-144 i g H \left(H^2 k^2+3\right) \right] - H (H^2 k^2+3\right) \ U^2 k^2-144 i g H \left(H^2 k^2+3\right) \ U k^2+48 e^2 + H (H^2 k^2+3) \ U k^2+4$ i \sqrt{3} g^2 H^2 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} k^2\right) \text{dt}^2}{36 g H \left(H^2 $\label{eq:continuity} $$ k^2+3\right)^2}+O\left(\frac{t}{3}\right)^3\right)+\left(\frac{t}{3}\right)+\left(\frac{t}{3}\right)^2\\+O\left(\frac{t}{3}\right)$ \left(H^2 k^2+3\right)} U k^6-9 i H^2 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U k^5+24 \sqrt{3} g H k^4-3 \sqrt{g H \left(H^2 k^2+3\right)} U k^4-27 i \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U k^3\right)}{9} $\left(-4 \text{ H}^2 \text{ k}^2-12\right)$ \sqrt{-g H k\^2 \left(H\^2 k\^2+3\right)}\+\frac{\left(-31 H\^4 \sqrt{g H \left(H\^2 k\^2+3\right)})} k^2+3\right)} U^2 k^9+164 \sqrt{3} g H^5 U k^9-99 i H^4 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U^2 $k^8-186 H^2 \sqrt{g H \left(\frac{h^2 k^2+3\right)} U^2 k^7+1008 \right)} H^3 U k^7-90 g H^3 \sqrt{g H^2 Left}$ $H \left(\frac{H^2 k^2 + 3 \right) }{h^2 - g H k^2 \left(\frac{H^2 k^2 + 3 \right) }{h^2 k^2 + 3 \right) } U^2 k^6 + 72 i \left(\frac{1}{3} \right) U^2 k^6 + 72 i \left(\frac{1}{$ $H^2 \left(H^2 k^2+3\right) \right) \left(H^2 k^2+3\right)$ $H k^2 \left(H^2 k^2 + 3 \right) k^6 - 279 \right) k^6 - 279 \right) H \left(H^2 k^2 + 3 \right) U^2 k^5 + 1548 \right) H U$ $k^5 - 360 \text{ g H } \left(H^2 k^2 + 3 \right) k^5 - 891 \text{ i } \left(-g \text{ H } k^2 \left(H^2 k^2 + 3 \right) \right) U^2$ $k^4 + 216 i \left(\frac{3} \left(\frac{3} \left(\frac{4^2 + 3\right)}{3} \right) \right) \left(\frac{4^2 + 3\right)}{3^2 + 2^2 +$ $i g H \sqrt{-g H k^2 \left(\frac{H^2 k^2+3\right)} k^4\right) \left(\frac{H^2 k^2+3\right)} k^4\right) \left(\frac{H^2 k^2+3\right)} k^4\left(\frac{H^2 k^2+3\right)} k^4\left$ H k^2 \left(H^2 k^2+3\right)}}+\frac{\left(-16 i \sqrt{3} H^8 U^4 k^{14}-192 i \sqrt{3} H^6 U^4 $k^{12}-1071 \text{ i } \text{H}^6 \operatorname{left}(\text{H}^2 \text{ k}^2+3\operatorname{right}) \text{ U}^3 \text{ k}^{12}+6120 \text{ i } \operatorname{sqrt}(3) \text{ g H}^7 \text{ U}^2 \text{ k}^{12}+1215 \text{ log}(1) \text{ log}(1)$ H^6 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U^3 k^{11}+4752 i \sqrt{3} g^2 H^6 k^{10}-864 i \sqrt{3} H^4 U^4 k^{10}-9675 i H^4 \sqrt{g H \left(H^2 k^2+3\right)} U^3 k^{10}+54486 i \sqrt{3} g H^5 U^2 $k^{10}-16830 i g H^{5} \left(H^{2} k^{2}+3\right) U k^{10}+10935 H^{4} \left(H^{2} H^{2} k^{2}+3\right)$ $k^2+3\right) U^3 k^9-5832 \sqrt{3} H^4 \sqrt{g H \left(\frac{h^2 k^2+3\right)} \sqrt{g H h^2 \left(\frac{h^2 k^2+3\right)} \right)}$ $k^2+3\right) U^2 k^9+17496 g H^5 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U k^9+33264 i \sqrt{3} g^2$ H⁴ k⁸-1728 i \sqrt{3} H² U⁴ k⁸-29133 i H² \sqrt{g H \left(H² k²+3\right)} U³ k⁸+161676 $i \sqrt{4} \ H^3 \ V^2 \ h^8 - 106650 \ i \ g \ H^3 \sqrt{g} \ H \left(H^2 \ h^2 + 3\right) \ U \ h^8 + 32805 \ H^2 \$ $H k^2 \left(\frac{h^2 k^2+3 \right) U^3 k^7-34992 \left(\frac{3}{H^2 \left(\frac{h^2 k^2+3 \right) \left(\frac{h^2 k^2+3$ k^2 \left(H^2 k^2+3\right)} U^2 k^7+109350 g H^3 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U k^7-4374 $\sqrt{3} g H^3 \sqrt{4^2 k^2+3 \cdot g}$ \sqrt{3} g H^3 \sqrt{g H \left(H^2 k^2+3 \right)} \sqrt{-g H k^2 \left(H^2 k^2+3 \right)} k^7-1296 i \sqrt{3} U^4 k^6-29241 i \sqrt{g H \left(H^2 k^2+3\right)} U^3 k^6+57024 i \sqrt{3} g^2 H^2 k^6+159894 i \sqrt{3} g H U^2 k^6-168480 i g H \sqrt{g H \left(H^2 k^2+3\right)} U k^6+32805 \sqrt{-g H k^2 $\label{eq:left(H^2 k^2+3\wedge ight)} $$ U^3 k^5-52488 \operatorname{sqrt}_3 \operatorname{left(H^2 k^2+3\wedge ight)} \operatorname{left(H^$ $k^2+3\right) U^2 k^5+170586 g H \sqrt{-g H k^2 \left(H^2 k^2+3\right) U k^5-17496 \right) U k^5-17496 c H k^2 (H^2 k^2+3\right) U k^5-17496 c H k^2 (H^2 k^2+3) U k^2 (H^2 k^2+3) U k^2 (H^2 k^2+3) U k^2 (H^2 k^2+3) U k^2 (H^2 k^2+4) U k^2 (H^2 k^2+3) U k^2 (H^2 k^2+4) U k^2 (H$ $\left(\frac{H^2 k^2+3\right)} \left(\frac{H^2 k^2+3\right)} \left(\frac{H^2 k^2+3\right)} k^5\right) \$ $\label{left} $$\left(H^2 k^2+3\right)^3 \right)^3 \left(H^2 k^2+3\right)^3+O\left(\frac{d^2 k^2+3\right)$ $k^4-2 \sqrt{3} H^2 \sqrt{g H \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{3} H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{3} H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{3} H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{3} H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{3} H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^4+2 i \sqrt{g H k^2 \left(H^2 k^2+3\right)} U$ $k^2+3\right) U k^3+9 g H k^2-6 \sqrt{8} t_g H \left(\frac{h^2 k^2+3\right) U k^2+6 i \sqrt{3} \right)$ $H k^2 \left(H^2 k^2 + 3 \right) U k - 3 i \left(H^2 k^2 + 3 \right) \left(H^2 k^2 +$ $k^5+36 \sqrt{3} g H^3 \sqrt{4 U k^5-i H^2 k^2+3 } U^2 k^5-108 g^2 H^4 U k^5-i H^2 \sqrt{4 U k^5-i H^2 k^5-$ $\left(H^2 k^2+3\right) \right] \sqrt{H^2 k^2+3}$ k^2 \left(H^2 k^2+3\right)} U^2 k^4+81 g H U^3 k^3+108 \sqrt{3} g H \sqrt{g H \left(H^2 k^2+3\right)} U^2 k^3-324 g^2 H^2 U k^3+54 \sqrt{3} g^2 H^2 \sqrt{g H \left(H^2 k^2+3\right)} k^3-3 i \sqrt{g H $\left(H^2 k^2+3\right) \left(H^2 k^2+3\right) \$ $\left(H^2 k^2+3\right) U^2 k^2+144 i g H \left(H^2 k^2+3\right) \right] \sqrt{2} k^2+144 i g H \left(H^2 k^2+3\right) \left(H^2 k^2+3\right)$ $k^2+3\right) U k^2-48 i \sqrt{3} g^2 H^2 \sqrt{-g H k^2 \left(H^2 k^2+3\right) k^2\right) k^2\right) (1+3) U k^2-48 i \sqrt{3} g^2 H^2 \sqrt{-g H k^2 \left(H^2 k^2+3\right) k^2\right) k^2\right)$ $g\ H \ left(H^2\ k^2+3\ right)^2\} + O\ left(\ text\{dt\}^3\ right) + left(-\ frac\{i\ left(6\ sqrt\{3\}\ g\ H^3\ k^6-H^2\ right)\} + left(-\ left(6\ sqrt\{3\}\ g\ H^3\ k^6-H^2\ right)) + left(-\ left(6\ sqrt\{3\}\ g\ H^3\ right)) + left(-\ left(6\ sqrt\{3\}\ g\ H^3\ right)) + left(-\ left(6\ sqrt\{3\}\ g\ H^3\ right)) + left(-\ left(6\ sqrt\{3\}\ right)) + left(-\ left(6\ sqrt\{4\}\ right)$ $\sqrt{g H \left(H^2 k^2+3\right)} U k^6+9 i H^2 \sqrt{g H k^2 \left(H^2 k^2+3\right)} U k^5+24$ $\$ \sqrt{3} g H k^4-3 \sqrt{g H \left(H^2 k^2+3\right)} U k^4+27 i \sqrt{-g H k^2 \left(H^2 k^2+3\right)} $\label{eq:uk^3\left(H^2 k^2-12\right)} $$ U k^3\right)_{9 \left(H^2 k^2-12\right)}+\frac{H^4 k^2 \left(H^2 k^2+3\right)}{H^4 k^2 h^2}. $$$ $\sqrt{3} g H \left(\frac{A^2 k^2 + 3 \right) U^2 k^9 - 164 \right) g H^5 U k^9 - 99 i H^4 \right) H^2 \left(\frac{A^2 k^2 + 3 \right) H^5 U k^9 - 99 i H^4 \right)$ k^2+3\right)} U^2 k^8+186 H^2 \sqrt{g H \left(H^2 k^2+3\right)} U^2 k^7-1008 \sqrt{3} g H^3 U $k^7+90 \text{ g H}^3 \sqrt{H^2 k^2+3\right} k^7-594 \text{ i H}^2 \sqrt{-g H k}^2 \left(\frac{H^2 k^2+3\right)} k^7-594 \text{ i H}^2 \right)$ $\label{left} $$U^2 \ k^6+72 \ i \ \P \ H^2 \ \|H^2 \ \|H^2$ $U \ k^6 - 162 \ i \ g \ H^3 \ sqrt\{-g \ H \ k^2 \ left(H^2 \ k^2 + 3 \ right)\} \ k^6 + 279 \ sqrt\{g \ H \ left(H^2 \ k^2 + 3 \ right)\}$ U^2 k^5-1548 \sqrt{3} g H U k^5+360 g H \sqrt{g H \left(H^2 k^2+3\right)} k^5-891 i \sqrt{-g H $k^2 \left(H^2 k^2 + 3 \right) U^2 k^4 + 216 i \left(H^2 k^2 + 3 \right) \left(H^2$ $\left(H^2 k^2+3\right) U k^4-648 i g H \left(H^2 k^2+3\right) k^4-g H k^2 \left(H^2 k^2+3\right) k^4\right) text{dt}{432}$ $\label{left(H^2 k^2+3\right)^2 \ h^6 U^4 h^6 U^4 h^6 U^4 h^6 U^4 Left(H^2 k^2+3\right)}} + \frac{16 i \ \text{u}^4 H^8 U^4 h^6 U^4 h$ $k^{14}+192 i \sqrt{14} H^6 U^4 k^{12}+1071 i H^6 \sqrt{14} H^1 k^2 k^2+3 \right) U^3 k^{12}-6120$ i \sqrt{3} g H^7 U^2 k^{12}+1215 H^6 \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U^3 k^{11}-4752 i \sqrt{3} g^2 H^6 k^{10}+864 i \sqrt{3} H^4 U^4 k^{10}+9675 i H^4 \sqrt{g H \left(H^2 k^2+3\right)} U^3 k^{10}-54486 i \sqrt{3} g H^5 U^2 k^{10}+16830 i g H^5 \sqrt{g H \left(H^2 k^2+3\right)} U $k^{10}+10935 + 4 \sqrt{10}+10935 + 4 \sqrt{10}+10935$ $k^2+3\right) \sqrt{9} 144 = 124$ k^2+3\right)} U k^9-33264 i \sqrt{3} g^2 H^4 k^8+1728 i \sqrt{3} H^2 U^4 k^8+29133 i H^2 \sqrt{g H \left(H^2 k^2+3\right)} U^3 k^8-161676 i \sqrt{3} g H^3 U^2 k^8+106650 i g H^3 \sqrt{g H \left(H^2 $\label{eq:k-2+3-right} $$ U $^8+32805 H^2 \sqrt{-g} H k^2 \left(H^2 k^2+3\right) U^3 k^7-34992 \right. $$$ $H^2 \left(H^2 k^2 + 109350 g H^3 + 109350 g H^3 + 109350 g H^3 H^2 \left(H^2 k^2 + 109350 g H^3 + 1093$ $\sqrt{y} H^2 \left(H^2 k^2 + \frac{1}{y} \right) U k^7 - 4374 \sqrt{3} g H^3 \left(H^2 k^2 + \frac{1}{y} \right)$ $\sqrt{9} H^2 \left(H^2 k^2+3\right) k^7+1296 i \right) U^4 k^6+29241 i \right]$ k^2+3\right)} U^3 k^6-57024 i \sqrt{3} g^2 H^2 k^6-159894 i \sqrt{3} g H U^2 k^6+168480 i g H \sqrt{3} \sqrt{g H \left(H^2 k^2+3\right)} \sqrt{-g H k^2 \left(H^2 k^2+3\right)} U^2 k^5+170586 g $H \left(-g H k^2 \left(H^2 k^2 + 3 \right) \right) U k^5 - 17496 \left(3 g H \right) H \left(H^2 k^2 + 3 \right)$ $\sqrt{g} H k^2 \left(h^2 k^2 + 3\right) k^5\right) + k^5\right) \left(h^2 k^2 + 3\right) \left(h^2 k^2 + 3\right) k^5\right)$ $\label{left} $$k^2 \left(\frac{dx}^3\right)\$

$$\begin{array}{l} \text{Out} \ \, | \ \, \left\{ \left\{ \frac{i\,\sqrt{3}\,\,k\,\sqrt{g\,H\,(3+H^2\,k^2)}}{3+H^2\,k^2} \, \frac{dt}{dt} + \left(-\frac{3\,g\,H\,k^2}{2\,(3+H^2\,k^2)} + \frac{\sqrt{3}\,\,k^2\,\sqrt{g\,H\,(3+H^2\,k^2)}}{3+H^2\,k^2} \, \frac{U}{dt} \right) dt^2 + O[dt]^3 \right\} + \\ \left(\frac{1}{6}\,\dot{i}\,\,k^3\,\,U\,\,dt + \left(\frac{3\,g\,H\,k^4}{(3+H^2\,k^2)^2} + \frac{3\,g\,H^3\,k^6}{4\,(3+H^2\,k^2)^2} + \frac{k^4\,U^2}{24} \right) dt^2 + O[dt]^3 \right) dx^2 + O[dx]^3, \\ \left(-\dot{i}\,H\,k\,dt + \left(\frac{\sqrt{3}\,\,H\,k^2\,\sqrt{g\,H\,(3+H^2\,k^2)}}{2\,(3+H^2\,k^2)} - H\,k^2\,U \right) dt^2 + O[dt]^3 \right) + \\ \left(\frac{1}{6}\,\dot{i}\,H\,k^3\,dt + \left(-\frac{H\,k^4\,\sqrt{g\,H\,(3+H^2\,k^2)}}{4\,\sqrt{3}\,(3+H^2\,k^2)} + \frac{7}{24}\,H\,k^4\,U \right) dt^2 + O[dt]^3 \right) dx^2 + O[dx]^3 \right\}, \\ \left\{ \left(-\frac{6\,i\,g\,k\,dt}{3+H^2\,k^2} + O[dt]^3 \right) + \left(\frac{i\,g\,(6\,k^3+H^2\,k^3)\,dt}{2\,(3+H^2\,k^2)^2} + O[dt]^3 \right) dx^2 + O[dx]^3 \right\}, \\ \left\{ \left(-\frac{6\,i\,g\,k\,dt}{3+H^2\,k^2} + O[dt]^3 \right) + \left(\frac{i\,g\,(6\,k^3+H^2\,k^3)\,dt}{2\,(3+H^2\,k^2)^2} + O[dt]^3 \right) dx^2 + O[dx]^3 \right\} \right\} \end{aligned}$$

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\begin{array}{cc}

 $\left(\frac{1 \operatorname{sqrt}{3} k \operatorname{sqrt}{g H \left(\frac{h^2 k^2+3\right)}} \left(\frac{4t}{H^2 k^2+3}\right) + \frac{4t}{H^2 k^2+3} + \left(\frac{h^2 k^2+3}{H^2 k^2+3}\right) \right)} \right)$ $H \left(H^2 k^2 + 3 \right) U \left(H^2 k^2 + 3 - \frac{3 g H k^2}{2 \left(H^2 k^2 + 3 \right) \right) \right)$ g H^3 k^6}{4 \left(H^2 k^2+3\right)^2}+\frac{U^2 k^4}{24}+\frac{3 g H k^4}{\left(H^2 $k^2+3\left(\frac{dx}^2+O\left(\frac{dx}^3\right)\right) \\ | k^2+3\right) \\ | k^2+3\left(\frac{dx}^2+O\left(\frac{dx}^3\right)\right) \\ | k^2+3\left(\frac{dx}^2+O\left(\frac{dx}^3\right)\right) \\ | k^2+3\left(\frac{dx}^2+O\left(\frac{dx}^3\right)\right) \\ | k^2+3\left(\frac{dx}^2+O\left(\frac{dx}^3\right)\right) \\ | k^2+3\left(\frac{dx}^3\right) \\ | k^2+3\left(\frac{dx}^3$ & $\left(-i \ H \ k \ \left(\frac{dt}{+}\right)\right)$ \left(\\frac{\sqrt{3} \ H \k^2 \sqrt{g \ H \left(H^2 \ k^2+3\right)}}{2 \left(H^2 \ k^2 + R)}\) $k^2+3\right)-H k^2 U\right) \text{ } \text{ } k^2+O\left(\frac{dt}^2+O\left(\frac{dt}^2\right)-\frac{dt}^2\right)-H k^2 U\right)$ $\t text{dt}+\left(\frac{7}{24} H k^4 U-\frac{H k^4 \sqrt{H k^4 \cdot grt{g H \left(\frac{H^2 k^2+3\right)}}}{4 \cdot grt{3} \left(\frac{H^2 k^4 - H k^4 \cdot grt{g H k^4 \cdot grt$ $\left(-\frac{6 i g k \text{dt}}{H^2 k^2+3}+O\left(\frac{dt}{3}\right)\right)\right) + \left(\frac{6 i g k \text{dt}}{H^2 k^2+3}+O\left(\frac{dt}{3}\right)\right)$ $k^5+6 k^3\right) \left(\frac{dt}{3} \right) \left(\frac{dt}{3}\right) \left$ $\text{dx}^2+O\left(\frac{dx}^3\right) & \left(\frac{dx}^2 + O\left(\frac{dx}^3\right) & \left(\frac{dx}^2 - \frac{dx}^2\right) \\$ $k^2+3\left(\frac{dt}{H^2} k^2+3\right)+O\left(\frac{dt}{3\right)}\left(\frac{dt}{3}\right)+\left(\frac{dt}{3}\right)$ \end{array} \right)