```
(%i1)  kill(all);
```

(%o0) *done*

```
(%i1)  load(ctensor);
```

(%o1) */usr/share/maxima/5.24.0/share/tensor/ctensor.mac*

```
(%i2)  ct_coords:[r,theta,phi,t];
```

(%o2) $[r, \theta, \phi, t]$

```
(%i3)  depends([%nu,%lambda],[t,r]);
```

(%o3) $[\nu(t,r), \lambda(t,r)]$

```
(%i4)  lg:matrix([-exp(%lambda),0,0,0],[0,-r^2,0,0],[0,0,-r^2*(sin(theta))^2,0],[0,0,0,exp(%
```

(%o4)
$$\begin{pmatrix} -e^{\lambda} & 0 & 0 & 0 \\ 0 & -r^2 & 0 & 0 \\ 0 & 0 & -r^2 \sin(\theta)^2 & 0 \\ 0 & 0 & 0 & e^{\nu} \end{pmatrix}$$

```
(%i5)  cmetric(true);
```

Doyouwishtoseethemetricinverse?y;

(%t5)
$$\begin{pmatrix} -e^{-\lambda} & 0 & 0 & 0 \\ 0 & -\frac{1}{r^2} & 0 & 0 \\ 0 & 0 & -\frac{1}{r^2 \sin(\theta)^2} & 0 \\ 0 & 0 & 0 & e^{-\nu} \end{pmatrix}$$

(%o5) *done*

```
(%i6)  /* last index is up in Gamma */
       christof(mcs);
```

(%t6) $$mcs_{1,1,1} = \frac{\frac{d}{dr}\lambda}{2}$$

(%t7) $$mcs_{1,1,4} = \frac{\left(\frac{d}{dt}\lambda\right) e^{\lambda-\nu}}{2}$$

(%t8) $$mcs_{1,2,2} = \frac{1}{r}$$

(%t9) $$mcs_{1,3,3} = \frac{1}{r}$$

(%t10) $$mcs_{1,4,1} = \frac{\frac{d}{dt}\lambda}{2}$$

(%t11) $mcs_{1,4,4} = \frac{\frac{d}{dr}\nu}{2}$

(%t12) $mcs_{2,2,1} = -e^{-\lambda}\, r$

(%t13) $mcs_{2,3,3} = \frac{\cos(\theta)}{\sin(\theta)}$

(%t14) $mcs_{3,3,1} = -e^{-\lambda}\, r \sin(\theta)^2$

(%t15) $mcs_{3,3,2} = -\cos(\theta)\ \sin(\theta)$

(%t16) $mcs_{4,4,1} = \frac{e^{\nu-\lambda}\ \left(\frac{d}{dr}\nu\right)}{2}$

(%t17) $mcs_{4,4,4} = \frac{\frac{d}{dt}\nu}{2}$

(%o17) *done*

```
(%i18) ricci(true);
```

(%t18) $ric_{1,1} = \frac{\frac{d}{dr}\lambda}{r} + \frac{\left(\frac{d}{dt}\lambda\right)\ e^{\lambda-\nu}\ \left(\frac{d}{dt}\nu\right)}{4} + \frac{\left(\frac{d}{dt}\lambda\right)\ e^{\lambda-\nu}\ \left(\frac{d}{dt}\lambda - \frac{d}{dt}\nu\right)}{2} - \frac{\frac{d^2}{dr^2}\nu}{2} - \frac{\left(\frac{d}{dr}\nu\right)^2}{4} + \frac{\left(\frac{d}{dr}\lambda\right)\ \left(\frac{d}{dr}\nu\right)}{4} + \frac{\left(\frac{d^2}{dt^2}\lambda\right)\ e^{\lambda-\nu}}{2} - \frac{\left(\frac{d}{dt}\lambda\right)^2 e^{\lambda-\nu}}{4}$

(%t19) $ric_{1,4} = \frac{\frac{d}{dt}\lambda}{r}$

(%t20) $ric_{2,2} = -\frac{e^{-\lambda}\ \left(\frac{d}{dr}\nu\right)\ r}{2} + \frac{e^{-\lambda}\ \left(\frac{d}{dr}\lambda\right)\ r}{2} - e^{-\lambda} + 1$

(%t21) $ric_{3,3} = -\frac{e^{-\lambda}\ \left(\frac{d}{dr}\nu\right)\ r\sin(\theta)^2}{2} + \frac{e^{-\lambda}\ \left(\frac{d}{dr}\lambda\right)\ r\sin(\theta)^2}{2} - e^{-\lambda}\sin(\theta)^2 + \sin(\theta)^2$

(%t22) $ric_{4,4} = \frac{e^{\nu-\lambda}\ \left(\frac{d}{dr}\nu\right)}{r} + \frac{\left(\frac{d}{dt}\lambda\right)\ \left(\frac{d}{dt}\nu\right)}{4} + \frac{e^{\nu-\lambda}\ \left(\frac{d^2}{dr^2}\nu\right)}{2} - \frac{e^{\nu-\lambda}\ \left(\frac{d}{dr}\nu\right)^2}{4} + \frac{e^{\nu-\lambda}\ \left(\frac{d}{dr}\nu\right)\ \left(\frac{d}{dr}\nu - \frac{d}{dr}\lambda\right)}{2} + \frac{\left(\frac{d}{dr}\lambda\right)\ e^{\nu-\lambda}\ \left(\frac{d}{dr}\nu\right)}{4} - \frac{\frac{d^2}{dt^2}\lambda}{2} - \frac{\left(\frac{d}{dt}\lambda\right)^2}{4}$

(%o22) *done*

```
(%i23) leinstein(true);
```

(%t23) $lein_{1,1} = \frac{\left(\frac{d}{dr}\nu\right)\ r - e^{\lambda} + 1}{r^2}$

(%t24) $lein_{2,2} = \frac{e^{-\nu-\lambda}\, r\ \left(\left(e^{\lambda}\ \left(\frac{d}{dt}\lambda\right)\ \left(\frac{d}{dt}\nu\right) + 2\, e^{\nu}\ \left(\frac{d^2}{dr^2}\nu\right) + e^{\nu}\left(\frac{d}{dr}\nu\right)^2 - \left(\frac{d}{dr}\lambda\right)\ e^{\nu}\ \left(\frac{d}{dr}\nu\right) - 2\, e^{\lambda}\ \left(\frac{d^2}{dt^2}\lambda\right) -$

(%t25) $lein_{3,3} = \dfrac{e^{-\nu-\lambda}\, r \left(\left(e^{\lambda} \left(\frac{d}{dt}\lambda\right) \left(\frac{d}{dt}\nu\right) + 2\, e^{\nu} \left(\frac{d^2}{dr^2}\nu\right) + e^{\nu} \left(\frac{d}{dr}\nu\right)^2 - \left(\frac{d}{dr}\lambda\right) e^{\nu} \left(\frac{d}{dr}\nu\right) - 2\, e^{\lambda} \left(\frac{d^2}{dt^2}\lambda\right) -\right.\right.}{4}$

(%t26) $lein_{4,1} = \dfrac{\frac{d}{dt}\lambda}{r}$

(%t27) $lein_{4,4} = \dfrac{e^{\nu-\lambda} \left(\left(\frac{d}{dr}\lambda\right) r + e^{\lambda} - 1\right)}{r^2}$

(%o27) *done*

```
(%i28) scurvature();
```

(%o28) $(e^{-\nu-\lambda}(\left(e^{\lambda} \left(\dfrac{d}{dt}\lambda\right) \left(\dfrac{d}{dt}\nu\right) + 2\, e^{\nu} \left(\dfrac{d^2}{dr^2}\nu\right) + e^{\nu} \left(\dfrac{d}{dr}\nu\right)^2 - \left(\dfrac{d}{dr}\lambda\right) e^{\nu} \left(\dfrac{d}{dr}\nu\right) - 2\, e^{\lambda} \left(\dfrac{d^2}{dt^2}\lambda\right) -\right.$
$\left(4\, e^{\nu} \left(\dfrac{d}{dr}\nu\right) - 4 \left(\dfrac{d}{dr}\lambda\right) e^{\nu}\right) r + \left(4 - 4\, e^{\lambda}\right) e^{\nu}))/(2\, r^2)$

```
(%i29) mu;
```

(%o29) μ

```
(%i30) %alpha;
```

(%o30) α

```
(%i31) %lambda;
```

(%o31) λ

```
(%i32) %mu;
```

(%o32) μ