Shape functions of Hex32

Coordinates of points in the reference space

In[2]:= `x = {(*1*){-1, -1, -1}, (*2*){1, -1, -1}, (*3*){1, 1, -1}, (*4*){-1, 1, -1}, (*5*)`
`{-1, -1, 1}, (*6*){1, -1, 1}, (*7*){1, 1, 1}, (*8*){-1, 1, 1}, (*9*){-1/3, -1, -1},`
`(*10*){1/3, -1, -1}, (*11*){1, -1/3, -1}, (*12*){1, 1/3, -1}, (*13*){1/3, 1, -1},`
`(*14*){-1/3, 1, -1}, (*15*){-1, 1/3, -1}, (*16*){-1, -1/3, -1}, (*17*)`
`{-1/3, -1, 1}, (*18*){1/3, -1, 1}, (*19*){1, -1/3, 1}, (*20*){1, 1/3, 1}, (*21*)`
`{1/3, 1, 1}, (*22*){-1/3, 1, 1}, (*23*){-1, 1/3, 1}, (*24*){-1, -1/3, 1}, (*25*)`
`{-1, -1, -1/3}, (*26*){-1, -1, 1/3}, (*27*){1, -1, -1/3}, (*28*){1, -1, 1/3},`
`(*29*){1, 1, -1/3}, (*30*){1, 1, 1/3}, (*31*){-1, 1, -1/3}, (*32*){-1, 1, 1/3}};`

Shape functions

In[3]:= `group1 = {9, 10, 13, 14, 17, 18, 21, 22}; (* points with r=+-1/3 *)`
`group2 = {11, 12, 15, 16, 19, 20, 23, 24}; (* points with s=+-/13*)`

In[5]:= `ShapeFunc[n_] :=`

$$\text{If}\Big[n \leq 8, \ \frac{1}{64} (1 + r \, x[\![n, 1]\!]) (1 + s \, x[\![n, 2]\!]) (1 + t \, x[\![n, 3]\!]) (9 \, r^2 + 9 \, s^2 + 9 \, t^2 - 19),$$

$$\text{If}\Big[\text{MemberQ}[\text{group1}, n], \ \frac{9}{64} (1 - r^2) (1 + 9 \, r \, x[\![n, 1]\!]) (1 + s \, x[\![n, 2]\!]) (1 + t \, x[\![n, 3]\!]),$$

$$\text{If}\Big[\text{MemberQ}[\text{group2}, n], \ \frac{9}{64} (1 + r \, x[\![n, 1]\!]) (1 - s^2) (1 + 9 \, s \, x[\![n, 2]\!]) (1 + t \, x[\![n, 3]\!]),$$

$$\frac{9}{64} (1 + r \, x[\![n, 1]\!]) (1 + s \, x[\![n, 2]\!]) (1 - t^2) (1 + 9 \, t \, x[\![n, 3]\!])\Big]\Big]\Big];$$

In[6]:= `AllShapeFunc = Table[ShapeFunc[m], {m, 32}];`

In[7]:= **AllShapeFunc // MatrixForm**

Out[7]//MatrixForm=

$$
\begin{pmatrix}
\frac{1}{64} (1-r)(1-s)(1-t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1+r)(1-s)(1-t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1+r)(1+s)(1-t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1-r)(1+s)(1-t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1-r)(1-s)(1+t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1+r)(1-s)(1+t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1+r)(1+s)(1+t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{1}{64} (1-r)(1+s)(1+t)(-19+9 r^2+9 s^2+9 t^2) \\
\frac{9}{64} (1-3 r)(1-r^2)(1-s)(1-t) \\
\frac{9}{64} (1+3 r)(1-r^2)(1-s)(1-t) \\
\frac{9}{64} (1+r)(1-3 s)(1-s^2)(1-t) \\
\frac{9}{64} (1+r)(1+3 s)(1-s^2)(1-t) \\
\frac{9}{64} (1+3 r)(1-r^2)(1+s)(1-t) \\
\frac{9}{64} (1-3 r)(1-r^2)(1+s)(1-t) \\
\frac{9}{64} (1-r)(1+3 s)(1-s^2)(1-t) \\
\frac{9}{64} (1-r)(1-3 s)(1-s^2)(1-t) \\
\frac{9}{64} (1-3 r)(1-r^2)(1-s)(1+t) \\
\frac{9}{64} (1+3 r)(1-r^2)(1-s)(1+t) \\
\frac{9}{64} (1+r)(1-3 s)(1-s^2)(1+t) \\
\frac{9}{64} (1+r)(1+3 s)(1-s^2)(1+t) \\
\frac{9}{64} (1+3 r)(1-r^2)(1+s)(1+t) \\
\frac{9}{64} (1-3 r)(1-r^2)(1+s)(1+t) \\
\frac{9}{64} (1-r)(1+3 s)(1-s^2)(1+t) \\
\frac{9}{64} (1-r)(1-3 s)(1-s^2)(1+t) \\
\frac{9}{64} (1-r)(1-s)(1-3 t)(1-t^2) \\
\frac{9}{64} (1-r)(1-s)(1+3 t)(1-t^2) \\
\frac{9}{64} (1+r)(1-s)(1-3 t)(1-t^2) \\
\frac{9}{64} (1+r)(1-s)(1+3 t)(1-t^2) \\
\frac{9}{64} (1+r)(1+s)(1-3 t)(1-t^2) \\
\frac{9}{64} (1+r)(1+s)(1+3 t)(1-t^2) \\
\frac{9}{64} (1-r)(1+s)(1-3 t)(1-t^2) \\
\frac{9}{64} (1-r)(1+s)(1+3 t)(1-t^2)
\end{pmatrix}
$$

In[8]:= `substitution = {`

```
    (1 - r) → rm, (1 - s) → sm, (1 - t) → tm,
    (1 + r) → rp, (1 + s) → sp, (1 + t) → tp,
    (1 - 3 r) → r3m, (1 - 3 s) → s3m, (1 - 3 t) → t3m,
    (1 + 3 r) → r3p, (1 + 3 s) → s3p, (1 + 3 t) → t3p,
    (1 - r²) → rr, (1 - s²) → ss, (1 - t²) → tt,
    9 r² → rr9, 9 s² → ss9, 9 t² → tt9
    };
```

In[9]:= `interp = AllShapeFunc /. substitution;`
`Print[CForm[interp]]`

```
List((rm*sm*tm*(-19 + rr9 + ss9 + tt9))/64.,(rp*sm*tm*(-19 + rr9 + ss9 +
    tt9))/64.,(rp*sp*tm*(-19 + rr9 + ss9 + tt9))/64.,(rm*sp*tm*(-19 + rr9 + ss9 +
    tt9))/64.,(rm*sm*tp*(-19 + rr9 + ss9 + tt9))/64.,(rp*sm*tp*(-19 + rr9 + ss9 +
    tt9))/64.,(rp*sp*tp*(-19 + rr9 + ss9 + tt9))/64.,(rm*sp*tp*(-19 + rr9 + ss9 +
    tt9))/64.,(9*r3m*rr*sm*tm)/64.,(9*r3p*rr*sm*tm)/64.,(9*rp*s3m*ss*tm)/64.,(9*rp*s3p*ss*tm)/64.,(9*
    r3p*rr*sp*tm)/64.,(9*r3m*rr*sp*tm)/64.,(9*rm*s3p*ss*tm)/64.,(9*rm*s3m*ss*tm)/64.,(9*r3m*rr*sm*tp)/
    64.,(9*r3p*rr*sm*tp)/64.,(9*rp*s3m*ss*tp)/64.,(9*rp*s3p*ss*tp)/64.,(9*r3p*rr*sp*tp)/64.,(9*r3m*rr*
    sp*tp)/64.,(9*rm*s3p*ss*tp)/64.,(9*rm*s3m*ss*tp)/64.,(9*rm*sm*t3m*tt)/64.,(9*rm*sm*t3p*tt)/64.,(9*
    rp*sm*t3m*tt)/64.,(9*rp*sm*t3p*tt)/64.,(9*rp*sp*t3m*tt)/64.,(9*rp*sp*t3p*tt)/64.,(9*rm*sp*t3m*tt)/
    64.,(9*rm*sp*t3p*tt)/64.)
```

Derivative of shape functions

In[11]:= `AllDerivShapeWrtR = D[AllShapeFunc, r];`
`AllDerivShapeWrtS = D[AllShapeFunc, s];`
`AllDerivShapeWrtT = D[AllShapeFunc, t];`

In[14]:= **AllDerivShapeWrtR // MatrixForm**

Out[14]//MatrixForm=

$$
\begin{pmatrix}
\frac{9}{32}(1-r)\,r\,(1-s)(1-t) - \frac{1}{64}(1-s)(1-t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}\,r\,(1+r)(1-s)(1-t) + \frac{1}{64}(1-s)(1-t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}\,r\,(1+r)(1+s)(1-t) + \frac{1}{64}(1+s)(1-t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}(1-r)\,r\,(1+s)(1-t) - \frac{1}{64}(1+s)(1-t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}(1-r)\,r\,(1-s)(1+t) - \frac{1}{64}(1-s)(1+t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}\,r\,(1+r)(1-s)(1+t) + \frac{1}{64}(1-s)(1+t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}\,r\,(1+r)(1+s)(1+t) + \frac{1}{64}(1+s)(1+t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
\frac{9}{32}(1-r)\,r\,(1+s)(1+t) - \frac{1}{64}(1+s)(1+t)\left(-19+9\,r^2+9\,s^2+9\,t^2\right) \\
-\frac{9}{32}(1-3\,r)\,r\,(1-s)(1-t) - \frac{27}{64}\left(1-r^2\right)(1-s)(1-t) \\
-\frac{9}{32}\,r\,(1+3\,r)(1-s)(1-t) + \frac{27}{64}\left(1-r^2\right)(1-s)(1-t) \\
\frac{9}{64}(1-3\,s)\left(1-s^2\right)(1-t) \\
\frac{9}{64}(1+3\,s)\left(1-s^2\right)(1-t) \\
-\frac{9}{32}\,r\,(1+3\,r)(1+s)(1-t) + \frac{27}{64}\left(1-r^2\right)(1+s)(1-t) \\
-\frac{9}{32}(1-3\,r)\,r\,(1+s)(1-t) - \frac{27}{64}\left(1-r^2\right)(1+s)(1-t) \\
-\frac{9}{64}(1+3\,s)\left(1-s^2\right)(1-t) \\
-\frac{9}{64}(1-3\,s)\left(1-s^2\right)(1-t) \\
-\frac{9}{32}(1-3\,r)\,r\,(1-s)(1+t) - \frac{27}{64}\left(1-r^2\right)(1-s)(1+t) \\
-\frac{9}{32}\,r\,(1+3\,r)(1-s)(1+t) + \frac{27}{64}\left(1-r^2\right)(1-s)(1+t) \\
\frac{9}{64}(1-3\,s)\left(1-s^2\right)(1+t) \\
\frac{9}{64}(1+3\,s)\left(1-s^2\right)(1+t) \\
-\frac{9}{32}\,r\,(1+3\,r)(1+s)(1+t) + \frac{27}{64}\left(1-r^2\right)(1+s)(1+t) \\
-\frac{9}{32}(1-3\,r)\,r\,(1+s)(1+t) - \frac{27}{64}\left(1-r^2\right)(1+s)(1+t) \\
-\frac{9}{64}(1+3\,s)\left(1-s^2\right)(1+t) \\
-\frac{9}{64}(1-3\,s)\left(1-s^2\right)(1+t) \\
-\frac{9}{64}(1-s)(1-3\,t)\left(1-t^2\right) \\
-\frac{9}{64}(1-s)(1+3\,t)\left(1-t^2\right) \\
\frac{9}{64}(1-s)(1-3\,t)\left(1-t^2\right) \\
\frac{9}{64}(1-s)(1+3\,t)\left(1-t^2\right) \\
\frac{9}{64}(1+s)(1-3\,t)\left(1-t^2\right) \\
\frac{9}{64}(1+s)(1+3\,t)\left(1-t^2\right) \\
-\frac{9}{64}(1+s)(1-3\,t)\left(1-t^2\right) \\
-\frac{9}{64}(1+s)(1+3\,t)\left(1-t^2\right)
\end{pmatrix}
$$

In[15]:= **AllDerivShapeWrtS // MatrixForm**

Out[15]//MatrixForm=

$$\begin{pmatrix} \frac{9}{32}(1-r)(1-s)s(1-t) - \frac{1}{64}(1-r)(1-t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1+r)(1-s)s(1-t) - \frac{1}{64}(1+r)(1-t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1+r)s(1+s)(1-t) + \frac{1}{64}(1+r)(1-t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1-r)s(1+s)(1-t) + \frac{1}{64}(1-r)(1-t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1-r)(1-s)s(1+t) - \frac{1}{64}(1-r)(1+t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1+r)(1-s)s(1+t) - \frac{1}{64}(1+r)(1+t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1+r)s(1+s)(1+t) + \frac{1}{64}(1+r)(1+t)\left(-19+9r^2+9s^2+9t^2\right) \\ \frac{9}{32}(1-r)s(1+s)(1+t) + \frac{1}{64}(1-r)(1+t)\left(-19+9r^2+9s^2+9t^2\right) \\ -\frac{9}{64}(1-3r)\left(1-r^2\right)(1-t) \\ -\frac{9}{64}(1+3r)\left(1-r^2\right)(1-t) \\ -\frac{9}{32}(1+r)(1-3s)s(1-t) - \frac{27}{64}(1+r)\left(1-s^2\right)(1-t) \\ -\frac{9}{32}(1+r)s(1+3s)(1-t) + \frac{27}{64}(1+r)\left(1-s^2\right)(1-t) \\ \frac{9}{64}(1+3r)\left(1-r^2\right)(1-t) \\ \frac{9}{64}(1-3r)\left(1-r^2\right)(1-t) \\ -\frac{9}{32}(1-r)s(1+3s)(1-t) + \frac{27}{64}(1-r)\left(1-s^2\right)(1-t) \\ -\frac{9}{32}(1-r)(1-3s)s(1-t) - \frac{27}{64}(1-r)\left(1-s^2\right)(1-t) \\ -\frac{9}{64}(1-3r)\left(1-r^2\right)(1+t) \\ -\frac{9}{64}(1+3r)\left(1-r^2\right)(1+t) \\ -\frac{9}{32}(1+r)(1-3s)s(1+t) - \frac{27}{64}(1+r)\left(1-s^2\right)(1+t) \\ -\frac{9}{32}(1+r)s(1+3s)(1+t) + \frac{27}{64}(1+r)\left(1-s^2\right)(1+t) \\ \frac{9}{64}(1+3r)\left(1-r^2\right)(1+t) \\ \frac{9}{64}(1-3r)\left(1-r^2\right)(1+t) \\ -\frac{9}{32}(1-r)s(1+3s)(1+t) + \frac{27}{64}(1-r)\left(1-s^2\right)(1+t) \\ -\frac{9}{32}(1-r)(1-3s)s(1+t) - \frac{27}{64}(1-r)\left(1-s^2\right)(1+t) \\ -\frac{9}{64}(1-r)(1-3t)\left(1-t^2\right) \\ -\frac{9}{64}(1-r)(1+3t)\left(1-t^2\right) \\ -\frac{9}{64}(1+r)(1-3t)\left(1-t^2\right) \\ -\frac{9}{64}(1+r)(1+3t)\left(1-t^2\right) \\ \frac{9}{64}(1+r)(1-3t)\left(1-t^2\right) \\ \frac{9}{64}(1+r)(1+3t)\left(1-t^2\right) \\ \frac{9}{64}(1-r)(1-3t)\left(1-t^2\right) \\ \frac{9}{64}(1-r)(1+3t)\left(1-t^2\right) \end{pmatrix}$$

In[16]:= **AllDerivShapeWrtT // MatrixForm**

Out[16]//MatrixForm=

$$\begin{pmatrix}
\frac{9}{32}(1-r)(1-s)(1-t)t - \frac{1}{64}(1-r)(1-s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1+r)(1-s)(1-t)t - \frac{1}{64}(1+r)(1-s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1+r)(1+s)(1-t)t - \frac{1}{64}(1+r)(1+s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1-r)(1+s)(1-t)t - \frac{1}{64}(1-r)(1+s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1-r)(1-s)t(1+t) + \frac{1}{64}(1-r)(1-s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1+r)(1-s)t(1+t) + \frac{1}{64}(1+r)(1-s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1+r)(1+s)t(1+t) + \frac{1}{64}(1+r)(1+s)\left(-19+9r^2+9s^2+9t^2\right) \\
\frac{9}{32}(1-r)(1+s)t(1+t) + \frac{1}{64}(1-r)(1+s)\left(-19+9r^2+9s^2+9t^2\right) \\
-\frac{9}{64}(1-3r)\left(1-r^2\right)(1-s) \\
-\frac{9}{64}(1+3r)\left(1-r^2\right)(1-s) \\
-\frac{9}{64}(1+r)(1-3s)\left(1-s^2\right) \\
-\frac{9}{64}(1+r)(1+3s)\left(1-s^2\right) \\
-\frac{9}{64}(1+3r)\left(1-r^2\right)(1+s) \\
-\frac{9}{64}(1-3r)\left(1-r^2\right)(1+s) \\
-\frac{9}{64}(1-r)(1+3s)\left(1-s^2\right) \\
-\frac{9}{64}(1-r)(1-3s)\left(1-s^2\right) \\
\frac{9}{64}(1-3r)\left(1-r^2\right)(1-s) \\
\frac{9}{64}(1+3r)\left(1-r^2\right)(1-s) \\
\frac{9}{64}(1+r)(1-3s)\left(1-s^2\right) \\
\frac{9}{64}(1+r)(1+3s)\left(1-s^2\right) \\
\frac{9}{64}(1+3r)\left(1-r^2\right)(1+s) \\
\frac{9}{64}(1-3r)\left(1-r^2\right)(1+s) \\
\frac{9}{64}(1-r)(1+3s)\left(1-s^2\right) \\
\frac{9}{64}(1-r)(1-3s)\left(1-s^2\right) \\
-\frac{9}{32}(1-r)(1-s)(1-3t)t - \frac{27}{64}(1-r)(1-s)\left(1-t^2\right) \\
-\frac{9}{32}(1-r)(1-s)t(1+3t) + \frac{27}{64}(1-r)(1-s)\left(1-t^2\right) \\
-\frac{9}{32}(1+r)(1-s)(1-3t)t - \frac{27}{64}(1+r)(1-s)\left(1-t^2\right) \\
-\frac{9}{32}(1+r)(1-s)t(1+3t) + \frac{27}{64}(1+r)(1-s)\left(1-t^2\right) \\
-\frac{9}{32}(1+r)(1+s)(1-3t)t - \frac{27}{64}(1+r)(1+s)\left(1-t^2\right) \\
-\frac{9}{32}(1+r)(1+s)t(1+3t) + \frac{27}{64}(1+r)(1+s)\left(1-t^2\right) \\
-\frac{9}{32}(1-r)(1+s)(1-3t)t - \frac{27}{64}(1-r)(1+s)\left(1-t^2\right) \\
-\frac{9}{32}(1-r)(1+s)t(1+3t) + \frac{27}{64}(1-r)(1+s)\left(1-t^2\right)
\end{pmatrix}$$

In[17]:= `derivR = AllDerivShapeWrtR /. substitution;`
`Print[CForm[derivR]]`

```
List((9*r*rm*sm*tm)/32. - (sm*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*r*rp*sm*tm)/32. +
  (sm*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*r*rp*sp*tm)/32. + (sp*tm*(-19 + rr9 + ss9 +
  tt9))/64.,(9*r*rm*sp*tm)/32. - (sp*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*r*rm*sm*tp)/32.
  - (sm*tp*(-19 + rr9 + ss9 + tt9))/64.,(9*r*rp*sm*tp)/32. + (sm*tp*(-19 + rr9 + ss9 +
  tt9))/64.,(9*r*rp*sp*tp)/32. + (sp*tp*(-19 + rr9 + ss9 + tt9))/64.,(9*r*rm*sp*tp)/32. -
  (sp*tp*(-19 + rr9 + ss9 + tt9))/64.,(-9*r*r3m*sm*tm)/32. - (27*rr*sm*tm)/64.,(-9*r*r3p*sm*tm)/32.
  + (27*rr*sm*tm)/64.,(9*s3m*ss*tm)/64.,(9*s3p*ss*tm)/64.,(-9*r*r3p*sp*tm)/32.
  + (27*rr*sp*tm)/64.,(-9*r*r3m*sp*tm)/32. -
  (27*rr*sp*tm)/64.,(-9*s3p*ss*tm)/64.,(-9*s3m*ss*tm)/64.,(-9*r*r3m*sm*tp)/32.
  - (27*rr*sm*tp)/64.,(-9*r*r3p*sm*tp)/32. +
  (27*rr*sm*tp)/64.,(9*s3m*ss*tp)/64.,(9*s3p*ss*tp)/64.,(-9*r*r3p*sp*tp)/32.
  + (27*rr*sp*tp)/64.,(-9*r*r3m*sp*tp)/32. -
  (27*rr*sp*tp)/64.,(-9*s3p*ss*tp)/64.,(-9*s3m*ss*tp)/64.,(-9*sm*t3m*tt)/64.,(-9*sm*t3p*tt)/64.,(9*sm*
  t3m*tt)/64.,(9*sm*t3p*tt)/64.,(9*sp*t3m*tt)/64.,(9*sp*t3p*tt)/64.,(-9*sp*t3m*tt)/64.,(-9*sp*t3p*tt)/
  64.)
```

In[19]:= `derivS = AllDerivShapeWrtS /. substitution;`
`Print[CForm[derivS]]`

```
List((9*rm*s*sm*tm)/32. - (rm*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*s*sm*tm)/32. -
  (rp*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*s*sp*tm)/32. + (rp*tm*(-19 + rr9 + ss9 +
  tt9))/64.,(9*rm*s*sp*tm)/32. + (rm*tm*(-19 + rr9 + ss9 + tt9))/64.,(9*rm*s*sm*tp)/32.
  - (rm*tp*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*s*sm*tp)/32. - (rp*tp*(-19 + rr9 + ss9 +
  tt9))/64.,(9*rp*s*sp*tp)/32. + (rp*tp*(-19 + rr9 + ss9 + tt9))/64.,(9*rm*s*sp*tp)/32. +
  (rm*tp*(-19 + rr9 + ss9 + tt9))/64.,(-9*r3m*rr*tm)/64.,(-9*r3p*rr*tm)/64.,(-9*rp*s*s3m*tm)/32.
  - (27*rp*ss*tm)/64.,(-9*rp*s*s3p*tm)/32. +
  (27*rp*ss*tm)/64.,(9*r3p*rr*tm)/64.,(9*r3m*rr*tm)/64.,(-9*rm*s*s3p*tm)/32.
  + (27*rm*ss*tm)/64.,(-9*rm*s*s3m*tm)/32. -
  (27*rm*ss*tm)/64.,(-9*r3m*rr*tp)/64.,(-9*r3p*rr*tp)/64.,(-9*rp*s*s3m*tp)/32.
  - (27*rp*ss*tp)/64.,(-9*rp*s*s3p*tp)/32. +
  (27*rp*ss*tp)/64.,(9*r3p*rr*tp)/64.,(9*r3m*rr*tp)/64.,(-9*rm*s*s3p*tp)/32.
  + (27*rm*ss*tp)/64.,(-9*rm*s*s3m*tp)/32. -
  (27*rm*ss*tp)/64.,(-9*rm*t3m*tt)/64.,(-9*rm*t3p*tt)/64.,(-9*rp*t3m*tt)/64.,(-9*rp*t3p*tt)/64.,(9*rp*
  t3m*tt)/64.,(9*rp*t3p*tt)/64.,(9*rm*t3m*tt)/64.,(9*rm*t3p*tt)/64.)
```

In[21]:= **`derivT = AllDerivShapeWrtT /. substitution;`**
`Print[CForm[derivT]]`

```
List((9*rm*sm*t*tm)/32. - (rm*sm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*sm*t*tm)/32.
    - (rp*sm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*sp*t*tm)/32. - (rp*sp*(-19
    + rr9 + ss9 + tt9))/64.,(9*rm*sp*t*tm)/32. - (rm*sp*(-19 + rr9 + ss9 +
    tt9))/64.,(9*rm*sm*t*tp)/32. + (rm*sm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*sm*t*tp)/32.
    + (rp*sm*(-19 + rr9 + ss9 + tt9))/64.,(9*rp*sp*t*tp)/32. + (rp*sp*(-19
    + rr9 + ss9 + tt9))/64.,(9*rm*sp*t*tp)/32. + (rm*sp*(-19 + rr9 + ss9 +
    tt9))/64.,(-9*r3m*rr*sm)/64.,(-9*r3p*rr*sm)/64.,(-9*rp*s3m*ss)/64.,(-9*rp*s3p*ss)/64.,(-9*r3p*rr*sp)
    /64.,(-9*r3m*rr*sp)/64.,(-9*rm*s3p*ss)/64.,(-9*rm*s3m*ss)/64.,(9*r3m*rr*sm)/64.,(9*r3p*rr*sm)/64.,(9
    *rp*s3m*ss)/64.,(9*rp*s3p*ss)/64.,(9*r3p*rr*sp)/64.,(9*r3m*rr*sp)/64.,(9*rm*s3p*ss)/64.,(9*rm*s3m*
    ss)/64.,(-9*rm*sm*t*t3m)/32. - (27*rm*sm*tt)/64.,(-9*rm*sm*t*t3p)/32. +
    (27*rm*sm*tt)/64.,(-9*rp*sm*t*t3m)/32. - (27*rp*sm*tt)/64.,(-9*rp*sm*t*t3p)/32. +
    (27*rp*sm*tt)/64.,(-9*rp*sp*t*t3m)/32. - (27*rp*sp*tt)/64.,(-9*rp*sp*t*t3p)/32. +
    (27*rp*sp*tt)/64.,(-9*rm*sp*t*t3m)/32. - (27*rm*sp*tt)/64.,(-9*rm*sp*t*t3p)/32. + (27*rm*sp*tt)/64.)
```