

# TENSOR

→Lnd: generate 3. order list with 0 in 2 dimensions (0.2s)	<pre>RAD XYZ DEC C= 'X' CHOME TENSOR3  USR 7: 6: 5: 4: 3: 2: 1:  &lt;&lt;&lt;0 03 &lt;0 033 &lt;0 03 &lt;0 033&gt; R2   R3   R4   COORD -Lnd   L+T</pre>	<pre>RAD XYZ DEC C= 'X' CHOME TENSOR3  USR 7: 6:  &lt;&lt;a11 a12&gt; &lt;a21 a22&gt; 5:  'A' 4:  A(m,n) 3:  (1 2) 2:  'a12' 1: R2   R3   R4   COORD -Lnd</pre>
L→T: generates tensor from list (2.2s) Tval: evaluate component (1s)	<pre>7: 6: 5: 4:  A(1,2) 3:  'a12' 2: 1:  'a21' R2   R3   R4   COORD Tsubst</pre>	<pre>7: 6:  &lt;&lt;a11 a12&gt; &lt;a21 a22&gt; 5:  'A' 4:  A(m,n) 3:  (1 2) 2:  'a12' 1:  'a21' R2   R3   R4   COORD Tsubst</pre>
use tensor A: 'A(1,2)' EVAL -> a12 2 1 A -> a21  Tval: tensor value Tsubst: substitute index	<pre>7: 6: 5: 4:  A(1,2) 3:  'a12' 2: 1:  'a21' R2   R3   R4   COORD Tsubst</pre>	<pre>7: 6:  &lt;&lt;a11 a12&gt; &lt;a21 a22&gt; 5:  'A' 4:  A(m,n) 3:  (1 2) 2:  'a12' 1:  'a21' R2   R3   R4   COORD Tsubst</pre>
L→T0: generates tensor from list indices start from 0 (2.2s) Tval: evaluate component (1s)	<pre>7: 6: 5: 4:  &lt;&lt;a00 a01&gt; &lt;a10 a11&gt; 3:  'A0' 2:  A0(k,1) 1:  (1 2) Tsubst   Tval   Tview   Aview -Lnd   L+T</pre>	<pre>7: 6: 5: 4:  A(k,1) 3:  'k' 2: 1:  A(1,1)+A(2,1) T+IV   T+OV   Ek   Ekl   HelpT   CST</pre>
Σk: sum over k (1s)	<pre>7: 6: 5: 4:  A(k,1) 3:  'k' 2: 1:  a21+a11+a22+a12 T+IV   T+OV   Ek   Ekl   HelpT   CST</pre>	<pre>7: 6: 5: 4:  'A0' 3:  &lt;&lt;a00 a01&gt; &lt;a10 a11&gt; 2: 1: L+T0   A+T   Tedit   Tsyn   Tsyn   TcurL</pre>
Σkl: sum over k l (1s)	<pre>7: 6: 5: 4:  A(k,1) 3:  'k' 2: 1:  a21+a11+a22+a12 T+IV   T+OV   Ek   Ekl   HelpT   CST</pre>	<pre>7: 6: 5: 4:  'A0' 3:  &lt;&lt;a00 a01&gt; &lt;a10 a11&gt; 2: 1: L+T0   A+T   Tedit   Tsyn   Tsyn   TcurL</pre>
Tedit: edit tensor components, press CONT after edit	<pre>7: 6: 5: 4:  A(k,1) 3:  'k' 2: 1:  a21+a11+a22+a12 T+IV   T+OV   Ek   Ekl   HelpT   CST</pre>	<pre>7: 6: 5: 4:  'A0' 3:  &lt;&lt;a00 a01&gt; &lt;a10 a11&gt; 2: 1: L+T0   A+T   Tedit   Tsyn   Tsyn   TcurL</pre>
R4: tensors in 4 dimensions Tview: view tensor (0.4s)	<pre>RAD XYZ DEC C= 'X' CHOME TENSOR R43  USR 7: 6: 5: 4: 3: 2: 1:  &lt;&lt;T00 T01 T02 T03&gt; &lt;T10 T11 T1&gt; Ekl   A+T   Tview   Tedit   Tsyn   Tsyn</pre>	<pre>RAD XYZ DEC C= 'X' CHOME TENSOR R33  USR 7: 6: 5: 4: 3: 2: 1:  &lt;&lt;T11 0 03 &lt;0 T22 03 &lt;0 0 T33&gt; HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>
Tview: view algebraic term with tensors (6s)	<pre>7: 6: 5: 4:  'T' 3: 2: 1:  &lt;&lt;T00 T01 T02 T03&gt; &lt;T10 T11 T1&gt; Ekl   A+T   Tview   Tedit   Tsyn   Tsyn</pre>	<pre>7: 6: 5: 4:  T(j,k)+S(j,k) 3: 2: 1:  &lt;&lt;T11 0 03 &lt;0 T22 03 &lt;0 0 T33&gt; HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>
use tensors	<pre>7: 6: 5: 4:  T(m,n) 3:  'V3' 2: 1:  'T12' V   T   S   n   E   S</pre>	<pre>7: 6: 5: 4:  &lt;&lt;(1 0 0 0) &lt;0 -1 0 0&gt; &lt;0 &gt; 3:  'E' 2:  &lt;&lt;&lt;(0 0 0 0) &lt;0 0 0 0&gt; &lt;0 &gt; 1:  &lt;&lt;(1 0 0 0) &lt;0 1 0 0&gt; &lt;0 0 &gt; HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>
Tview: η Minkowski metric, ε Levi Civita symbol, δ Kronecker Delta	<pre>7: 6: 5: 4:  T(m,n) 3:  'V3' 2: 1:  'T12' V   T   S   n   E   S</pre>	<pre>7: 6: 5: 4:  &lt;&lt;(1 0 0 0) &lt;0 -1 0 0&gt; &lt;0 &gt; 3:  'E' 2:  &lt;&lt;&lt;(0 0 0 0) &lt;0 0 0 0&gt; &lt;0 &gt; 1:  &lt;&lt;(1 0 0 0) &lt;0 1 0 0&gt; &lt;0 0 &gt; HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>
Σ03: sum over one or several indices (5s)	<pre>7: 6: 5: 4:  T(j,k) 3:  'j' 2:  T(0,k)+T(1,k)+T(2,k)+T(3,k) 1:  T30+T20+T10+T00+T31+T21+T11+T01 E03   Contr4   d   D   HelpT</pre>	<pre>7: 6: 5: 4:  T(j,k) 3:  'j' 2:  T(j,k) 1:  T00+T11+T22+T33 E03   Contr4   d   D   HelpT</pre>
Contr4: contraction of indices (1.2s)	<pre>7: 6: 5: 4:  T(j,k) 3:  'j' 2:  T(j,k) 1:  T30+T20+T10+T00+T31+T21+T11+T01 E03   Contr4   d   D   HelpT</pre>	<pre>7: 6: 5: 4:  T(j,k) 3:  'j' 2:  T(j,k) 1:  T00+T11+T22+T33 E03   Contr4   d   D   HelpT</pre>
Tval: evaluate covariant derivatives (2s)	<pre>7: 6: 5: 4: 3:  d(T(m,n),k) 2:  (0 1 2) 1:  ∂/∂x0 (T12) HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>	<pre>7: 6: 5: 4: 3:  D(T(m,n),k) 2:  (0 1 2) 1:  ∂/∂x0 (T12) HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>
contravariant derivatives	<pre>7: 6: 5: 4: 3:  d(T(m,n),k) 2:  (0 1 2) 1:  ∂/∂x0 (T12) HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>	<pre>7: 6: 5: 4: 3:  D(T(m,n),k) 2:  (0 1 2) 1:  ∂/∂x0 (T12) HelpT   Tsubst   Tval   Tview   Aview -Lnd</pre>

<p>Σ03: sum over m, n (9s) η = Minkowski metric</p> <p>Contr4: contraction</p>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       V(m)*η(m,n)*V(n)       (m n) V0^2-V1^2-V2^2-V3^2 Σ03 Contr4  d   0   HelpT </pre>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       T(j,k)*δ(j,k)       (j k) T00+T11+T22+T33 Σ03 Contr4  d   0   HelpT </pre>
<p>Σ03: sum over m, n (8s)</p> <p>Contr4: contraction</p>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       T(j,k)*η(j,k)       (j k) T00-T11-T22-T33 Σ03 Contr4  d   0   HelpT </pre>	<pre> RAD XYZ DEC IC= 'R' CHONE TENSOR R43 USR 9: 8: 7: 6: 5: 4: 3: 2: 1:       d(V(m),n)       (m) 3/80*(V0)+3/81*(V1)+3/82*(V2)+3/83*(V3) Σ03 Σ03 Contr4  d   0   HelpT </pre>
<p>R3: tensors in 3 dimensions various tensors</p> <p>Σ13: sum over indices (6s)</p>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       'T'       (T11 T12 T13) (T21 T2)       (e)       ((0 0 0) (0 0 1) (0 -1 0)       (δ)       ((1 0 0) (0 1 0) (0 0 1)) V   T   s   e   Σ13 Contr3 </pre>	<pre> RAD XYZ DEC IC= 'R' CHONE TENSOR R43 USR 9: 8: 7: 6: 5: 4: 3: 2: 1:       d(V(m),n)       (m) 3/80*(V0)+3/81*(V1)+3/82*(V2)+3/83*(V3) Σ03 Σ03 Contr4  d   0   HelpT </pre>
<p>R3: tensors in 3 dimensions various tensors</p> <p>Tval: value of algebraic expression (3.5s)</p> <p>Tview: view algebraic (5s)</p>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       'T'       (T11 T12 T13) (T21 T2)       (e)       ((0 0 0) (0 0 1) (0 -1 0)       (δ)       ((1 0 0) (0 1 0) (0 0 1)) V   T   s   e   Σ13 Contr3 </pre>	<pre> 9: 8: 7: 6: 5: 4: 3: 2: 1:       V(a)*V(b)*V(c)*e(a,b,c)       (1 2 3)       V3*V2*V1       V(a)*V(b)       ((V1^2 V2*V1 V3*V1) (V2*V HelpT Tsubs  Tool Tview Aview  +Lnd </pre>
<p>Help:</p>	<p>TENSOR ALGEBRA, CALCULUS K: ORDER TENSOR: 'T(n1,...,nK)' NOTE: i,s ARE NOT ALLOWED AS INDICES (use i1,e1) R2,R3,R4 TENSORS IN 2,3,4 DIM. COORD COORDINATES +Lnd n d + LIST OF LISTS OF... n. ORDER TENSOR IN d DIM. WITH ALL ELEMENTS = 0 L+T,d C3 'T' + - LIST+TENSOR GRAPH        OK</p>	<p>L+T,d C3 'T' + - LIST+TENSOR C3 STORED IN 'T' INDEX FROM 1..0..0..n-1 A+T 'A(K1,...,K(C1))' + 'T' + TENSOR STORED IN 'T' Tview 'T' 'T(C1,...,C3) + C33 VIEW TENSOR ALSO IN TERMS Aview 'T(C1,...,C3) + C33 VIEW ALG. TERM WITH TENSORS Tedit 'T' + C33, EDIT LIST PRESS CONT AFTER EDIT CHANGES STORED IN 'T' GRAPH        OK</p>
<p>Help:</p>	<p>Tsym SYMMETRIC TENSOR T(C1,K(C1)) Cj k (C1) + Tsym Tasyh ANTISYMMETRIC TENSOR T(C1,K(C1)) Cj k (C1) + Tasyh Tval T0 + Cn1...nK2 + T(n1,...,nK) T0 n1 + T(C1,n1...) ALPHABETIC ORDER OF VARS Tsubst T(C1,...,Cj j1...j + T(C1,j1...) SUBSTITUTE INDEX T+IV TERM + INDEPENDENT VARS 'T(C1,k1)' + Cj k2 T+DV TERM + DEPENDENT VARS GRAPH        OK</p>	<p>T0 n1 + T(C1,n1...) ALPHABETIC ORDER OF VARS Tsubst T(C1,...,Cj j1...j + T(C1,j1...) SUBSTITUTE INDEX T+IV TERM + INDEPENDENT VARS 'T(C1,k1)' + Cj k2 T+DV TERM + DEPENDENT VARS 'T(C1,k1)*R(C1)' + Ck T3 Tcurl 'T(C1)' + d(C1n1)-d(C1n) CURL OF 1. ORDER TENSOR Ek T(C1,...,K k1 k2 + E Ek1 T(C1,...,K k1 k2 + E2 GRAPH        OK</p>