Exercises 7.2

4. Compute all polynomial coefficients of the shape functions of a 10-node tetrahedron element.

```
clear all
clc
```

```
syms xi eta zeta
syms a1 a2 a3 a4 a5 a6 a7 a8 a9 a10
syms c1 c2 c3 c4 c5 c6 c7 c8 c9 c10
```

```
Cxyz = a1 + a2*xi + a3*eta + a4*zeta + ...
    a5*xi^2 + a6*eta^2 + a7*zeta^2 + ...
    a8*xi*eta + a9*xi*zeta + a10*eta*zeta;
```

```
x = linspace (0, 1, 3);

eqs =[subs(Cxyz,[xi eta zeta],[x(1) x(1) x(1)]) == c1, ...
    subs(Cxyz,[xi eta zeta],[x(3) x(1) x(1)]) == c2,...
    subs(Cxyz,[xi eta zeta],[x(1) x(3) x(1)]) == c3,...
    subs(Cxyz,[xi eta zeta],[x(1) x(1) x(3)]) == c4,...
    subs(Cxyz,[xi eta zeta],[x(2) x(1) x(1)]) == c5,...
    subs(Cxyz,[xi eta zeta],[x(2) x(2) x(1)]) == c6,...
    subs(Cxyz,[xi eta zeta],[x(1) x(2) x(1)]) == c7,...
    subs(Cxyz,[xi eta zeta],[x(1) x(1) x(2)]) == c8,...
    subs(Cxyz,[xi eta zeta],[x(2) x(1) x(2)]) == c9,...
    subs(Cxyz,[xi eta zeta],[x(1) x(2) x(2)]) == c10];

var = [a1, a2,a3, a4, a5, a6, a7, a8, a9, a10];
Cvar = [c1, c2, c3, c4, c5, c6, c7, c8, c9, c10];
```

```
A = solve(eqs,var);
a1 = A.a1;
a2 = A.a2;
a3 = A.a3;
a4 = A.a4;
a5 = A.a5;
a6 = A.a6;
a7 = A.a7;
a8 = A.a8;
a9 = A.a9;
a10 = A.a10;
```

```
Cxyz = a1 + a2*xi + a3*eta + a4*zeta + ...
    a5*xi^2 + a6*eta^2 + a7*zeta^2 + ...
    a8*xi*eta + a9*xi*zeta + a10*eta*zeta;
```

```
[N,Ci] = coeffs(Cxyz,Cvar);
N1  = simplify(N( 1))
```

$$N1 = 2\eta^2 + 4\eta\xi + 4\eta\zeta - 3\eta + 2\xi^2 + 4\xi\zeta - 3\xi + 2\zeta^2 - 3\zeta + 1$$

```
N2  = simplify(N( 2))
```

$$N2 = \xi\,(2\xi - 1)$$

```
N3  = simplify(N( 3))
```

N3 = $\eta\ (2\,\eta - 1)$

```
N4  = simplify(N( 4))
```

N4 = $\zeta\ (2\,\zeta - 1)$

```
N5  = simplify(N( 5))
```

N5 = $-4\,\xi\ (\eta + \xi + \zeta - 1)$

```
N6  = simplify(N( 6))
```

N6 = $4\,\eta\,\xi$

```
N7  = simplify(N( 7))
```

N7 = $-4\,\eta\ (\eta + \xi + \zeta - 1)$

```
N8  = simplify(N( 8))
```

N8 = $-4\,\zeta\ (\eta + \xi + \zeta - 1)$

```
N9  = simplify(N( 9))
```

N9 = $4\,\xi\,\zeta$

```
N10 = simplify(N(10))
```

N10 = $4\,\eta\,\zeta$

```
sum (N(1)+N(2)+N(3)+N(4)+N(5)+N(6)+N(7)+N(8)+N(9)+N(10))
```

ans = 1