```
> with(linalg); A := matrix(3, 3, [a, 1,-1,-1, a, 1, 1,-1, a]);
```

[BlockDiagonal, GramSchmidt, JordanBlock, LUdecomp, QRdecomp, Wronskian, addcol, addrow, adj, adjoint, angle, augment, backsub, band, basis, bezout, blockmatrix, charmat, charpoly, cholesky, col, coldim, colspace, colspan, companion, concat, cond, copyinto, crossprod, curl, definite, delcols, delrows, det, diag, diverge, dotprod, eigenvals, eigenvalues, eigenvectors, eigenvects, entermatrix, equal, exponential, extend, ffgausselim, fibonacci, forwardsub, frobenius, gausselim, gaussjord, geneqns, genmatrix, grad, hadamard, hermite, hessian, hilbert, htranspose, ihermite, indexfunc, innerprod, intbasis, inverse, ismith, issimilar, iszero, jacobian, jordan, kernel, laplacian, leastsqrs, linsolve, matadd, matrix, minor, minpoly, mulcol, mulrow, multiply, norm, normalize, nullspace, orthog, permanent, pivot, potential, randmatrix, randvector, rank, ratform, row, rowdim, rowspace, rowspan, rref, scalarmul, singularvals, smith, stackmatrix, submatrix, subvector, sumbasis, swapcol, swaprow, sylvester, toeplitz, trace, transpose, vandermonde, vecpotent, vectdim, vector, wronskian]

$$A := \begin{bmatrix} a & 1 & -1 \\ -1 & a & 1 \\ 1 & -1 & a \end{bmatrix} \qquad (1)$$

```
> v := matrix(3, 1, [k, n, p]);
```

$$v := \begin{bmatrix} k \\ n \\ p \end{bmatrix} \qquad (2)$$

$e_i \cdot A \begin{pmatrix} k \\ n \\ p \end{pmatrix} - (k, n, p)\, A \begin{pmatrix} k \\ n \\ p \end{pmatrix}$

```
> B := multiply(A, v);
```

$$B := \begin{bmatrix} a\,k + n - p \\ a\,n - k + p \\ a\,p + k - n \end{bmatrix} \qquad (3)$$

```
> C1 := simplify(multiply([1, 0, 0], B) - multiply([k, n, p], B))k;
```

$$k' = C1 := \left(\left[\ a\,k + n - p\ \right] - \left[\ a\,(k^2 + n^2 + p^2)\ \right] \right) k \qquad (4)$$

```
> C2 := simplify(multiply([0, 1, 0], B) - multiply([k, n, p], B))n;
```

$$n' = C2 := \left(\left[\ a\,n - k + p\ \right] - \left[\ a\,(k^2 + n^2 + p^2)\ \right] \right) n \qquad (5)$$

```
> C3 := simplify(multiply([0, 0, 1], B) - multiply([k, n, p], B))p;
```

$$p' = C3 := \left(\left[\ a\,p + k - n\ \right] - \left[\ a\,(k^2 + n^2 + p^2)\ \right] \right) p \qquad (6)$$

```
> F1(k, n, p) := (a k + n-p - a (k^2 + n^2 + p^2))k;
```

$$F1 := (k, n, p) \mapsto \left(a\,k + n - p - a\,(n^2 + k^2 + p^2)\right) k \qquad (7)$$

```
> GF1 := grad(F1(k, n, p), [k, n, p]);
```

$$GF1 := \qquad (8)$$

$$\left[\ (-2\,a\,k + a)\,k + a\,k + n - p - a\,(k^2 + n^2 + p^2) \quad (-2\,a\,n + 1)\,k \quad (-2\,a\,p - 1)\,k\ \right]$$

> $V := matrix\left(3, 3, \left[\frac{1}{9}a, \frac{1}{3} - \frac{2}{9}a, -\frac{1}{3} - \frac{2}{9}a, -\frac{1}{3} - \frac{2}{9}a, \frac{1}{9}a, \frac{1}{3} - \frac{2}{9}a, \frac{1}{3} - \frac{2}{9}a, -\frac{1}{3} - \frac{2}{9}a, \frac{1}{9}a\right]\right);$

$$V := \begin{bmatrix} \frac{a}{9} & \frac{1}{3} - \frac{2a}{9} & -\frac{1}{3} - \frac{2a}{9} \\ -\frac{1}{3} - \frac{2a}{9} & \frac{a}{9} & \frac{1}{3} - \frac{2a}{9} \\ \frac{1}{3} - \frac{2a}{9} & -\frac{1}{3} - \frac{2a}{9} & \frac{a}{9} \end{bmatrix} \tag{9}$$

$Y' = VY$

> $eigenvectors(V);$

$$\left[-\frac{a}{3}, 1, \{[1 \;\; 1 \;\; 1]\}\right], \left[\frac{a}{3} + \frac{I\sqrt{3}}{3}, 1, \left\{\left[-\frac{1}{2} + \frac{I\sqrt{3}}{2} \;\; -\frac{1}{2} - \frac{I\sqrt{3}}{2} \;\; 1\right]\right\}\right], \left[\frac{a}{3} - \frac{I\sqrt{3}}{3}, 1, \left\{\left[-\frac{1}{2} - \frac{I\sqrt{3}}{2} \;\; -\frac{1}{2} + \frac{I\sqrt{3}}{2} \;\; 1\right]\right\}\right] \tag{10}$$

>

$-\frac{a}{3}$, $\frac{a}{3} \pm ?i$

$\left[\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right]$

nezajímavé

$a > 0$ $\quad \mathrm{Re}\,\lambda > 0 \Rightarrow$ nestabilní

$a < 0$ $\quad \mathrm{Re}\,\lambda < 0 \Rightarrow$ asymptoticky stab.

$a = 0$ $\quad \mathrm{Re}\,\lambda = 0 \Rightarrow$?