

routh(coeffs, eps)

The function takes an array of coefficients representing a characteristic equation and the number eps, which may replace zeros.

For example, obtain the characteristic equation of a system, then compute its Routh-array for stability analysis.

```
clear; syms s K_p K_i K;

sys1 = K/(s*(s+1)*(s+2)) + 1; % Unity gain system.

sys2 = 1 + K_p*(2/(s^3 + 4*s^2 + 5*s + 2)); % P-controlled system.

K_p = 3; % Keeping one parameter constant.
sys3 = 1 + (K_p + K_i/s)*(2/(s^3 + 4*s^2 + 5*s + 2)); % PI-controlled system.

coeffs = ELAB.sd2ce(sys3)
```

```
coeffs = (1 4 5 8 2 K_i)
```

```
RA = ELAB.routh(coeffs)
```

```
RA =
```

$$\begin{pmatrix} 1 & 5 & 2 K_i \\ 4 & 8 & 0 \\ 3 & 2 K_i & 0 \\ 8 - \frac{8 K_i}{3} & 0 & 0 \\ 2 K_i & 0 & 0 \end{pmatrix}$$

critical(RA)

Takes a Routh-array and attempts to find critical values, important for stability analysis.

```
ELAB.critical(RA, true)
```

Solving equations for param:

$$8 - \frac{8 K_i}{3} = 0$$

$$2 K_i = 0$$

For stability, param (K) =]3;0[

From s^2 auxiliary equation:

$$(3 s^2 + 3 = 0 \quad 3 s^2 = 0)$$

Solved for s:

$$\begin{pmatrix} -i & 0 \\ i & 0 \end{pmatrix}$$

