Technische Universität Berlin

Numerical Acoustics – Exercise 1

1. Eigenvalues and eigenvectors ....

Matrix A equals

$$A = \begin{Bmatrix} 3 & 0 \\ -9 & 6 \end{Bmatrix}. \tag{1}$$

(a) Determine the eigenvalues of the matrix A.

(b) Determine the eigenvectors of the matrix A.

2. Difference quotient ....

Complex amplitude of a plane acoustic wave $p = \hat{p}(x)e^{j\omega t}$ equals

$$\hat{p}(x) = 0.5e^{-j0.9\text{m}^{-1}x}\,\text{Pa}. \tag{2}$$

Calculate the complex amplitude of velocity, $\hat{v}(x)$, at $x = 1$m:

(a) analytically ($\rho_0 \approx 1.2$ kg/m^3 and $c_0 \approx 343$ m/s),

(b) numerically (from the conservation of momentum), using forward/backward/central difference quotient with $\Delta x = 0.1$m and with $\Delta x = 0.5$m.

3. Interpolation ....

A 10 Hz sinusoidal signal is measured with the sampling frequency 50Hz.

(a) Determine the FFT of the sampled signal.

(b) Interpolate the measured data linearly to double the number of support (sampling) points. Determine the FFT of the linearly interpolated signal.

(c) Interpolate the measured data with natural cubic spline interpolation to increase the number of support points by factor of 2 and 100. Determine the FFT of the spline-interpolated signals. (Note: use the class *CubicSpline* from the Python package *scipy*, sub-package *interpolate*.)