Inhaltsverzeichnis

1 Introduction 1

2 Waves 7
   2.1 Waves in earth ................................. 7
      2.1.1 Linear elastic theory and Hooke’s law ............... 7
   2.2 Categorization of waves .......................... 9
      2.2.1 Body waves .................................. 9
      2.2.2 Surface waves ................................ 10
      2.2.3 Reflection and refraction of waves at free boundaries .................................. 11
   2.3 Wave equations ................................ 12
      2.3.1 Elastic wave equation .......................... 13
      2.3.2 Acoustic wave equation .......................... 13
      2.3.3 Viscoacoustic waves ........................... 14
   2.4 Boundaries ...................................... 15
      2.4.1 Reflecting boundaries ........................... 15
      2.4.2 Absorbing boundaries ........................... 15

3 Absorbing boundaries 17
   3.1 Paraxial approximations ........................... 18
   3.2 Perfectly-matched layers .......................... 20
      3.2.1 Perfectly-Matched Layers (PML) in Acoustic Wave Equation 23
      3.2.2 Perfectly-Matched Layers (PML) in Elastic Wave Equation 24

4 Fourier transformation 25
   4.1 Fourier Series .................................... 29
   4.2 Discretization of the Fourier Transform ............. 30
   4.3 Discretization of the Inverse Fourier Transform .... 30
   4.4 Discussion ....................................... 31

5 Numerical methods for wave equations 33
   5.1 Finite element method (FEM) ........................ 33
      5.1.1 Weak Formulation of the Acoustic Equation .......... 34
      5.1.2 Weak Formulation of the Elastic Equation .......... 38
      5.1.3 Shape Functions ................................ 39

6 Seismic inversion 43
   6.1 Full waveform inversion (FWI) ...................... 44
      6.1.1 Definition of the inverse problem in the frequency domain .......... 44
      6.1.2 Discrete approach and discrete adjoint method ........... 46
      6.1.3 Continuous approach and functional gradient .......... 47
      6.1.4 Relation between discrete and continuous gradients ....... 48
      6.1.5 Comparison of the discrete and continuous gradients ....... 49
   6.2 Important concepts of an inverse problem .......... 50