Seismic Wave Propagation

a) **Review of travel-time functions and ray theory:**
plane waves and Snell's law, asides on Fourier transforms, multiple meanings of dimensions and (in)homogeneous, travel-time functions (T(p), X(p), τ(p), dX/dp), ray types (direct, reflected, turning, head, triplications) , non-geometrical effects (critical points, caustics, shadows)

b) **Review of continuum mechanics:**
traction vector, stress, strain, stiffness, compliance tensors, equation of motion, constitutive relations (isotropic, TI, anisotropic), boundary conditions, Bond transform, alternative notations (Voigt, Auld, Woodhouse)

c) **Wave equation:**
moment-density tensor, Navier equation, P and S waves, Christoffel equation, Betti's theorem, Green function, reciprocity, representation theorem, point and line source

d) **Source theory:**
stress glut, force equivalents, asymmetric moment tensor, indigenous and non-indigenous sources, Burridge-Knopoff slip-discontinuity, visualization and interpretation of moment tensors (Hudson-Pearce-Rogers and Riedesel-Jordan), principal axes and biaxes

e) **Asymptotic ray theory:**
ray series, eikonal and transport equations, Hamiltonian, slowness surface and wavefront, kinematic and dynamic ray equations, geometrical spreading and Poynting vector, effective ray length, linear anisotropic velocity, isotropic *v.* anisotropic ray theory, quasi-isotropic ray theory

f) **Reflection-transmission coefficients:**
plane waves and Snell's law, 1D transformed wave equation, eigensolutions, symplectic and up-down symmetry, Zoeppritz and anisotropic coefficients, reciprocity and energy conservation, coefficient differentials

g) **Layer-matrix methods:**
fundamental and propagator matrices, Jacobi identity, inhomogeneous equation symplectic symmetry, Haskell matrices, Kennett ray expansion, WKBJ asymptotic and iterative (Bremmer) solutions, Langer asymptotic expansion, stable numerical solutions

h) **Slowness methods:**
slowness v. spectral methods, numerical v. asymptotic *v.* exact *v.* approximate methods, Cagniard-de Hoop and WKBJ seismograms, canonical signals (direct, reflected, critical points, head waves, interface waves, reversed branch, triplications, caustics, shadows) and ray extensions

This course covers basic theoretical aspects of seismic body wave propagation. Most of the material is based on *Fundamentals of Seismic Wave Propagation*, C.H. Chapman (2004) with revisions, additions and updates. Time and expertise constraints mean that some obvious topics are omitted, but if time permits I will try to add some recent advances.