GPGN660: Mathematics of Seismic Imaging and Migration
Course Syllabus: Spring 2011

1. Historical overview of migration
2. Forward modeling/inversion (1D)
   (a) Green's theorem, Perturbation theory, Radiation conditions
   (b) The (1D) Born approximation, Born approximate modeling formula
   (c) 1D inversion (migration) formula
   (d) WKBJ Green's function, Born-WKBJ modeling/inversion (migration) theory
   (e) Multiples
   (f) Sampling and bandlimiting
   (g) variable density, forward modeling and inversion
3. Forward modeling/inversion (3D)
   (a) Green's theorem, Perturbation theory, Radiation conditions
   (b) The (3D) Born approximation, Born approximate modeling formula
   (c) Constant-background zero-offset Born inversion
   (d) Comparison with Stolt Migration,
   (e) Inversion (migration) for reflectivity 3D, 2.5D, 1.5D
   (f) Zero-offset Kirchhoff modeling, Kirchhoff approximation
   (g) Stationary phase in multi-dimensions
   (h) Differential geometry issues
   (i) Asymptotic analysis via stationary phase of the Kirchhoff modeling
   (j) Kirchhoff inversion formulas, 3D, 2.5D
   (k) The singular function and reflectors
   (l) Aperture limited singular functions
4. Inversion in Heterogeneous Media
5. General form of modeling/inversion formulas
6. Kirchhoff-WKBJ style forward modeling/inversion formulas
7. Ray theory I, kinematics/dynamics
8. Inversion (migration) in heterogeneous media with non-constant offset

(a) Derivation of general program of formulas

(b) Common shot

(c) Common offset i

9. Aperture-limited Fourier Inversion

   (a) Aperture limiting and migration dip

   (b) Aperture limiting and survey parameters

10. Ray theory II, 2.5D in-plane propagation

11. Inversion in 2.5D

   (a) Common Shot

   (b) Vertical seismic profiling

   (c) Crosswell

12. Transformation or Migration to Zero offset

   (a) dip-moveout (DMO), transformation to zero offset (TZO), data continuation, datuming

   (b) Kirchhoff Data Mapping, DMO, TZO

13. Modern issues

   (a) Angle domain inversion

   (b) Seismic interferrometry

   (c) modern mathematical topics

In addition to the classical mathematical methods listed in the syllabus, there students will be given a view toward more modern mathematical issues that may have application in new research in seismic imaging, migration, and inversion.

Textbook for the course:
Norman Bleistein, Jack K. Cohen, John W. Stockwell Jr., [2001],
Mathematics of multidimensional seismic imaging, migration, and inversion,
(Interdisciplinary Applied Mathematics, V. 13.), Springer-Verlag, New York.