

Numerical modeling in Geophysics

S. No	Theory	Lab	Theory hours	Lab hours
1	Intro to forward and inverse problems	Intro to MATLAB and GitHub	2	2
2	Discretization Projectile motion example Overdetermined-underdetermined Seismic tomo example	Projectile motion example	4	2
3	Interpolation and linear regression	(1) Polynomial interpolation (2) Lagrange and spline interpolation	4	6
4	Taylor series and Newtons method	Taylor series example	2	2
5	Numerical differentiation, Generalized matrix method for numerical derivatives	Solutions to ODE using Euler and RK4	4	2
6	Numerical integration	Difference in trapezoidal and Simpson's solutions	2	2
7	Iterative solvers	Jacobi and Gauss Seidel method	2	2
Mid Sem				
8	Basic elements of Finite difference method (explicit, implicit, crank- Nicolson)	-	4	0
9	Heat equation using Finite difference method	Example 1: Numerical solution to heat equation using FDM	2	4
10	Acoustic equation using Finite difference method	Example 2: Numerical solution to acoustic equation using FDM	2	4
11	Basic idea of finite element method	-	2	0
			30	26

Geophysical Inversion

S. No	Theory	Lab	Theory hours	Lab hours
1	Intro to forward and inverse problems Treasure hunt problem	Intro to MATLAB and GitHub	2	0
2	Revision of linear algebra (null space, rank, eigenvectors)	Properties eigenvalues and eigenvectors	2	2
3	Taylor series (gradient and hessian)	Linear regression problem	4	2
4	Linear and non-linear inverse problems	Example 1: Vertical Seismic Profiling (VSP) linear vs non-linear	4	4
5	Iterative methods	Gradient vs newton method	2	2
6	Earthquake location problem	Example 2: Hypocenter Inversion	2	2
Mid Sem				
7	Probabilistic viewpoint: Weighted least-square and gaussian pdf	-	4	0
8	Regularization and Lagrange multiplier	An example of Lagrange multipliers	2	2
9	SVD	(1) Properties of SVD (2) Image compression	4	4
10	Tomography inversion	Example 3: Crosswell Borehole tomography	2	4
11	Inverse problems using basis functions	Shaw Problem	4	2
			32	24