

Course Outline for Programming and Numerical Methods for Scientists (tentative)

		Class topics	In-class activity	Out-of-class assignment
Part 1: computing & C++	1	Basic computer model, machine code, and binary numbers	“Altair Z80”	Multiply two numbers
	2	Imperative languages, compilers, libraries, and linkers. C and Fortran and C++.	gcc, VC. Hello world.	temperature conversion
	3	C/C++ part 1: basic types, operators and precedence, scope, flow control, I/O	Bouncing ball	“Adventure”
	4	Testing code, documenting code, revision control	Modify bouncing ball to bouncing bubble	Further improve bubble or adventure
	5	C++ part 2: structs, pointers and references, classes, templates	Project: Accretion	
Part 2: numerical methods	6	Differential equation solvers in 1 dim.	Euler’s method	Runge-Kutta, orbits.
	7	PDE solvers (e.g., Laplace)	Image charges	Relaxation, thermal model
	8	Root-finding and minimization.	Newton’s method; Golden section search	Minimum-fuel rocket path
	9	Data-fitting, linear and non-linear.	Voltmeter calibration	Fitting problems: planetary orbits
	10	Monte Carlo integration & simulation	Volume of sphere; time to sort cards	Stability regions around multiple stars
Part 3: statistics	11	Statistics: means, rms, probability distributions	Light-bulb lifetime	Project: large astronomical data set from SIMBAD, VIZIER, or exoplanet.eu.
	12	Hypothesis testing; significance.	Light-bulb models.	
	13	Confidence intervals and regions.	Confidence region on parameters of light-bulb PDF.	
	14	Feldman-Cousins technique with MC.	Estimating lifetimes on long-lived light-bulb.	