Brookhaven National Laboratory SciComp 101
Foundations of Scientific Computing using Python

Topics	Source Code File

Session 01 - Introducing Scientific Computing

SciComp vs. CompSci, Workshop Overview	
SciComp as the Pathway to Internships	
Job Opportunities in Scientific Computing	
Using the Thonny IDE	hello_world.py
TASK 01 - Code Editing and Managing Files	my_quip.py

Session 02 - Python Fundamentals

Order of Operations (PEMDAS)	pemdas.py
Variables and Dimensional Analysis	age_in_weeks.py
NumPy Arrays, Indexes, and Element Values	numpy_arrays.py
Vectorized Operations	gauss_summation.py
TASK 02 - Time Conversion	age_in_seconds.py

Session 03 - Making Line Graphs

Plotting (matplotlib)	line_graphs.py
Linear Graphs and Intersection Points	fahrenheit_to_celsius.py
Infinite Sums & Convergence	basel_problem.py
Psudeo Random Number Generators	coprime_probability.py
TASK 03 - Fundamental Theorem of Algebra	plot_quintic.py

Session 04 - Functions and Logic

Functions, Boolean Conditions, Mod Operator	perfect_numbers.py
Estimation of the Base of Natural Logarithm	random_straws.py
Numba, Histograms, Probability Distributions	collatz_conjecture.py
Population Pairwise Comparison	birthday_paradox.py
TASK 04 - Infinite Series	leibniz_formula.py

Session 05 - Square Roots and Areas

Iterative Root Finding, Epsilon as Error	newton_sqrt.py
Numeric Precision, Rate of Convergence	herons_method.py
Complex Number Algebra	euler_identity.py
Integration using Riemann Sums	circle_area.py
TASK 05 - Power Series	logarithm_series.py

Session 06 - Polar Coordinates

Polar to Cartesian Coordinate Conversion	plot_circle.py
Polar Projection, Parametric Equations	plot_rose_curves.py
Sinusoid Superposition, Angle Product Identity	plot_superposition.py
Brownian Motion	random_walk.py
TASK 06 - Radius of Curvature	archimedes_spiral.py

Session 07 - Probability and Statistics

Mean, Variance, Std Deviation	hero_abilities.py
Median and Mode	common_statistics.py
Moment of Distribution	uniform_variance.py
Normal Distribution, Central Limit Theorem	pachinko_normal.py
Gauss Circle Problem	lattice_circle.py
TASK 07 - Maxwell/Boltzmann Distribution	maxwell_boltzmann.py

Session 08 - Histograms and Code Breaking

Encodings, ASCII, UTF-8	reverse_string.py
Reading Text Files	freq_histogram.py
Frequency Analysis, Bigrams	caesar_decrypt.py
Bigram Frequency Analysis	bigram_frequency.py
Bigram Cryptanalysis	bigram_decrypt.py
TASK 08 - Decrypt File	ciphertext2.txt

Session 09 - Measuring Waves

Nyquist Sampling - Known Wavelength	nyquist_known.py
Nyquist Sampling - Unknown Wavelength	nyquist_unknown.py
Frequency, Phase, Superposition	standing_waves.py
Surface Sampling	sampling_circle.py
TASK 09 - Angle Product Identity	werner_formula.py

Session 10 - Random Numbers and Algorithms

Encoding, Python Lists	list_cards.py
Boolean Data Type, Helper Data Structures	dealer_bogus.py
Random Numbers, Instrumentation	dealer_slow.py
Randomness without Reptition	dealer_fast.py
Algorithimc Efficiency	prime_racer1-3.py
TASK 10 - Number Theory	lcm_from_gcd.py

Session 11 - 3D Graphics

3D Cartesian Coordinates	plot3d_monolith.py
Oblique Projection, Vertices, Facets	plot3d_pyramid.py
Helical Spirals	plot3d_helix.py
Spherical Coordinates	plot3d_sphere.py
Volume of Revolution	plot3d_torus.py
Surface Plot, Mesh Grid	plot3d_surface.py
TASK 11 - Cylindrical Coordaintes	plot3d_cylinder.py

Session 12 - Monte Carlo Methods

Random Sampling	mc_circle_prng.py
Fixed Grid	mc_circle_grid.py
Quasi-Random Numbers	mc_circle_halton.py
Pythagorean Theorem	mc_sphere.py
Halton QRNG - Four Dimensions	mc_hypersphere.py
High Dimensional Hyperspheres	mc_high_dimensions.py
TASK 12 - Area of a Parabola	mc_parabola.py

Session 13 - Using Data Files

Key-Value Pairs, REPL	python_dictionaries.py
JSON Format	write_json.py
Comparing Isotype Half-life	read_json.py
Periodic Table of Elements	plot_liquid_range.py
Linear Regression - Gaussian Line of Best Fit	identify_element.py
TASK 13 - Cosmic Ray Kinematics	plot_trajectory.py

Session 14 - Coding for Physics

Equation of Motion, Kinematics	projectile_motion.py
Exponential Decay, Euler's Method, Carbon-14	nuclear_decay.py
Simple Harmonic Motion	simple_pendulum.py
TASK 15 - Newtonian Kinematics	rocket_propulsion.py

Session 15 - Coding for Biology and Chemistry

Genetic Homologs	seq_lrss.py
DNA Transcription, Codons, Open Reading Frames	seq_orf.py
Epidemiology, S-I-R Compartment Model	epidemiology.py
Balacing Ionic Equations	stoichiometry.py
TASK 14 - Combustion Reaction of Gasoline	octane_combustion.py

Session 16 - Linear Equations

Vector Algebra, Norm, Dot Product	dot_product.py
Basis Set, Orthgonality	basis_vectors.py
Matrices, Dimensions, Shape	matrix_shape.py
Matrix Multiplication	matrix_multiplication.py
Matrix Determinants and Inversion	matrix_determinant.py
Cramer's Rule, Matrix Algebra	solve_3x3.py
TASK 16 - Solving Systems of Linear Equations	solve_4x4.ipynb

Session 17 - Maze Searching

Binary Encoding and Binary Data Files	maze_draw.py
Depth First Search, Recursion, Stacks	maze_search.py
Adjacency Matrices	maze_adjaceny.py
TASK 17 - Network Branching Factor	maze.csv.pickle

Session 18 - Dynamical Systems

Stable Orbits, Strange Attractors, Bifurcation	logistics_map.py
Copmplex Iteration, Escape Time, Color Spaces	mandlebrot_set.py
Affine Transformation, Sierpinski's Triangle	ifs_triangle
Transformation Matrices, Barnsley's Fern	if_fern.py
Iterated Function Systems, Information Density	ifs_bnl.py
Barnsley's Collage Theorem	ifs_square.py
TASK 18 - Create a Hexagonal Fractal	ifs_hexagonal.py

Session 19 - Continued Fractions

Continued Fractions Taxonomy	std_continued_fractions.py
Generalized Continued Fractions	gen_continued_fractions.py
Period of Continued Fraction Expansion	pells_equation.py
TASK 19 - Binary Digit Population Count	hamming_weight.py

Session 20 - Machine Learning

Convex Hull, Dot Product, Jarvis March	convex_hull.py
k-Means Clustering, Cluster Eviction	k_means.py
TASK 20 - Factoring a Quadratic	factor_quadratic.py

Session 21 - Jenga Blocks

Center of Mass, Object Oriented Design	jenga_14.py
Cantilever Equilibrium	jenga_15.py
Moment of Inertia, Tipping Point	plot_centers.py

Session 22 - Scramble Squares

Integer Encoding, Recursive Search	scramble_squares.py