**Review Sheet – Final ChE 310 Spring 2019**

**NOTE:** The final is cumulative; however, the emphasis will be on the last unit. These problems will require you to remember past skills in addition to the new techniques.

**Unit III**

* Design of Experiments
	+ What is it? Why do we care?
	+ Types of DoE
		- Screening design
		- Fractional factorial, full factorial
		- Response surface design
			* bbdesign
			* ccdesign
	+ Fitting results of response surface design
		- Dropping parameters
		- Optimization
* Numerical Differentiation
	+ Types of numerical differentiation methods (table)
	+ Richardson extrapolation
	+ Derivatives from noisy experimental data
	+ Partial derivatives
	+ **diff** and **gradient**
* Numerical Integration
	+ Tabulated data
		- Trapezoidal rule
		- Simpson’s rules (1/3, 3/8)
		- **trapz**, **cumtrapz**, **polyint**
	+ Integrals from functions
		- Romberg integration w/ Richardson extrapolation
		- Gauss quadrature
		- **integral**, **integral2**, **integral3**
* Ordinary Differential Equations
	+ Initial Value Problems
		- First order and second order
		- Euler
		- 2nd order methods
			* Huen (not iterative)
			* Midpoint
		- 4th order Runge Kutta
			* **rk4sys**
		- Solving problems that are systems of ODEs
	+ Adaptive Methods
		- Step halving
		- Embedded or Fehlberg methods (**ode23**, **ode45**)
	+ Stiff Problems
		- What are they?
		- **ode15s** and **ode23s**
	+ Boundary Value Problems
		- What are they?
		- Types of boundaries
			* Constant (Dirichlet)
			* Rates (Neumann)
		- Shooting Method
			* Linear equations with interpolation (not important)
			* All equations with root finding (important!)
		- Finite Difference
			* Convert ODE to algebraic expression
			* Coefficient matrix, solve as system of equations
			* SLOW, if given option use shooting method

**Unit II**

* Root finding
	+ Graphical
	+ Bracketed methods
		- Bisection
		- False position
	+ Open methods
		- Fixed point iteration (successive substitution)
		- Newton Raphson method
		- Secant method
	+ Matlab tools
		- fzero
		- roots
	+ Excel solver
* Optimization (root finding)
	+ Global vs. local
	+ Golden search
	+ fminbnd
	+ fminsearch
	+ fmincon
* Systems of linear equations and matrix math
	+ Setting up system of equations from conservation type problems
	+ Condition and determinant
	+ Gauss elimination
	+ Partial pivoting
	+ LU factorization
	+ \ command
	+ Gauss seidel method
	+ Sparse (banded) matrix
		- Setting up from finite element problems
		- tridiag function
* Matrix inverse and other matrix measures
	+ Calculating the inverse
	+ Stimulus response problems
	+ Norm of matrix
	+ Condition number
* Systems of Non-linear Equations
	+ Graphical
	+ Multidimensional Newton Raphson
	+ newtmult algorithm with Jacobian
	+ fsolve
* Curve Fitting: Basic linear regression
	+ Regression vs. interpolation – when to use each method
	+ Residual
	+ Sum of squares of residuals
	+ Quantification of error
		- Coefficient of determination
			* What does it mean?
	+ polyfit
	+ fit
	+ plotting with confidence intervals
* Curve Fitting: Non-linear regression
	+ How linear least squares problems are reduced to a system of linear equations using ‘normal’ equations (15.1-15.2)
	+ General linear least squares (15.3)
	+ polyfit
	+ fit
	+ Curve Fitting Toolbox (cftool)
	+ Automating fits
		- Extracting goodness of fit measures
		- Extracting coefficients
		- Extracting confidence intervals

**Unit I**

* MATLAB basics
	+ Use of basic built-in functions (e.g. sin, exp, round, abs)
	+ M-files: scripts vs. functions, concept of scope
	+ Anonymous functions/function handles
	+ Accessing and assigning array variables
	+ Colon notation, linspace/logspace functions
	+ Boolean expressions: relational and logical operators
	+ If… ElseIf… Else structures
	+ For loops
	+ While loops, error estimation, and stopping criteria
	+ Nesting of loops
	+ Data import/export (to screen as well as to file)
	+ Plotting: plot/semilog/loglog functions, fplot function, subplots
* Statistics and measurement
	+ Accuracy and precision
	+ Types and sources of error
	+ True error, relative error, defining error tolerance
	+ Built-in MATLAB statistical functions
		- mean, median, mode, std, iqr
		- Plotting: box, histogram
	+ Probability density functions, cumulative density functions, MATLAB tools for fitting distributions and generating data according to those distributions
* Interpolation
	+ *Order* of polynomials and relationship to size of data set
	+ Newton/LaGrange methods for creating interpolating polynomials
	+ MATLAB polynomial syntax
	+ Built-in functions for finding and using interpolating polynomials: polyfit, polyval
	+ Multi-dimensional interpolation
	+ Piecewise interpolation and built-in functions (interp1, interp2)
	+ Splines: common types, implementation in MATLAB
* Differentiation
	+ Forward, backward, central difference formulas
	+ $O(h^{n})$ truncation error notation
	+ Differentiation of discrete data sets
	+ Differentiation of functions
	+ Differentiation strategies for unevenly spaced data