



Signal Processing and Analysis (AP4011)

Course Overview

Instructor: Chi-Kuang Chao

Department of Atmospheric Sciences, National Central University

Graduate Institute of Space Science, National Central University

September 13, 2016

Syllabus

- Instructor: Chi-Kuang Chao (趙吉光)
- Assistant: Tsung-En Tseng (曾從恩, ext 36755 or 65781, josh82127@gmail.com)
- Course type: core course.
- Classroom: S4-807.
- Lecture time: 3 hours/week.
- Lecture hours: 15:00-17:00 (TUE) and 15:00-16:00 (WED).
- Office hour: 16:00-17:00 (WED).

Objectives

- An introduction to students about techniques required for **numerical approximation** and **data processing**.
- **Mathematics + Programming** → Physics.
 - Applied mathematics (AP2007B and AP2008B)
 - Computer programming and graphics I and II (AP2049B and AP2050B)

Course outline

- **Numeric analysis**
 - Numerics in general
 - Numerics linear algebra
 - Numerics for ODEs and PDEs
- Optimization, Graphs
 - Unconstrained optimization - linear programming
 - Graphs - combinatorial optimization
- **Data reduction and error analysis**

Numerics in general

- Introduction
- Solution of equations by iteration
- Interpolation
- Spline interpolation
- Numeric integration and differentiation

Numerics linear algebra

- Linear systems: Gauss elimination
- Linear systems: LU-factorization, matrix inversion
- Linear systems: solution by iteration
- Linear systems: ill-conditioning, norms
- Least squares method
- Matrix eigenvalue problems: introduction
- Inclusion of matrix eigenvalues
- Power method for eigenvalues
- Tridiagonalization and QR-factorization

Numerics for ODEs and PDEs

- Methods for first-order ODEs
- Multistep methods
- Methods for systems and higher order ODEs
- Methods for elliptic PDEs
- Neumann and mixed problems - irregular boundary
- Methods for parabolic PDEs
- Methods for hyperbolic PDEs

Data reduction and error analysis

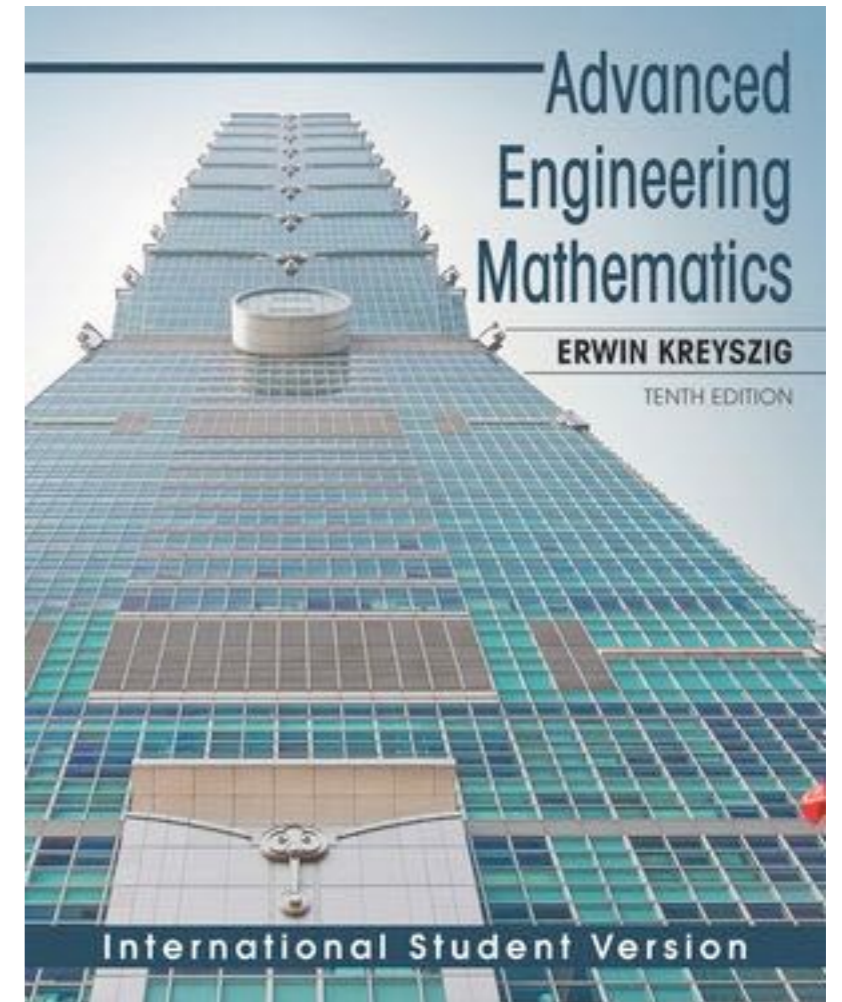
- Systematic and random errors
- Mean and standard deviation
- Distributions
- Propagation of errors
- Estimates of mean and errors
- Least-squares fit to a straight line
- Correlation probability

Data reduction and error analysis (cont.)

- Least-squares fit to a polynomial
- Multiple regression
- Goodness of fit
- Least-squares fit to an arbitrary function
- Fitting composite curves
- Data manipulation

Course materials

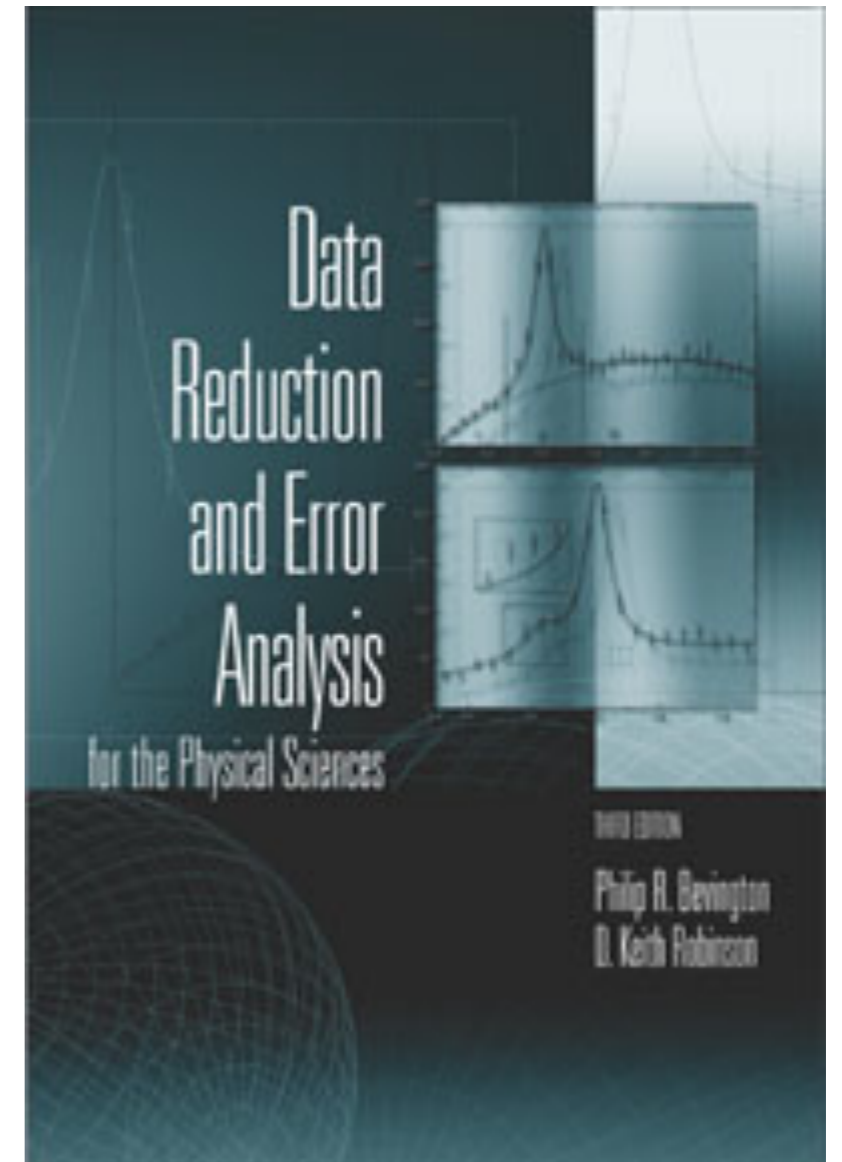
- **Textbook I**
- **Kreyszig, E., Advanced Engineering Mathematics, 10/E, John Wiley & Sons, Ltd., 2011.**
- **Paperback:** ISBN: 978-0-470-64613-7.
- **E-book:** ISBN: 978-1-118-00615-3.



WILEY

Course materials (cont.)

- **Textbook 2**
 - **Bevington, P. R. and D. K. Robinson, Data Reduction and Error Analysis for the Physical Sciences, 3/E, McGraw-Hill Higher Education, 2003.**
 - **Paperback:** ISBN: 0-07-247227-8.



Grading

- Five homework, no mid-term or final tests.
 - HW#1: 20%
 - HW#2: 20%
 - HW#3: 20%
 - HW#4: 20%
 - HW#5: 20%

Progress

Semester	2014/09	2015/03	2015/09	2016/03	2016/09	2017/03
Course	Signal Processing and Analysis	—	Signal Processing and Analysis	—	Signal Processing and Analysis	—
Students	34	—	40	—	32	—
Failed	8	—	1	—	—	—
Evaluation	4.16	—	4.27	—	—	—

Week #	1st session	2nd session	3rd session
1 (9/13 & 9/14)	Numerics in general.		
2 (9/20 & 9/21)	Numerics in general.		
3 (Typhoon Megi, 9/27 & 9/28)	Break.		
4 (10/4 & 10/5)	Numerics in general.		
5 (10/11 & 10/12)	Numerics linear algebra.		
6 (10/18 & 10/19)	Numerics linear algebra.		
7 (10/25 APSCO & 10/26)	Break but reschedule to 16:00-16:50 10/12 and 10/19.		Numerics linear algebra.
8 (11/1 & 11/2)	Numerics linear algebra.		
9 (mid-term, 11/8 & 11/9)	Break.		
10 (11/15 & 11/16 Game Day)	Numerics for ODEs and PDEs.		Break.
11 (11/22 & 11/23)	Numerics for ODEs and PDEs.		
12 (11/29 & 11/30)	Numerics for ODEs and PDEs.		
13 (12/6 & 12/7)	Break but reschedule to 16:00-16:50 11/23 and 11/30.		Numerics ODEs & PDEs.
14 (12/13 & 12/14)	Data reduction and error analysis.		
15 (12/20 & 12/21)	Data reduction and error analysis.		
16 (12/27 & 12/28)	Data reduction and error analysis.		
17 (1/3 & 1/4)	Data reduction and error analysis.		
18 (final, 1/10 & 1/11)	Break.		

For more information

- Please visit the course web page at <http://athena.ss.ncu.edu.tw/>
- Contact me
 - By phone: 03-4227151
 - Ext.65754 at S4-804 (office)
 - Ext.36755 at S4-820 (SPL - learning facilities)
 - Ext.65781 at S4-805-1 (SPL - core facilities)
 - By e-mail: ckchao@jupiter.ss.ncu.edu.tw