

# **Physics 5350: Methods of Theoretical Physics II**

## **Spring Semester, 2018**

### **Utah State University Department of Physics**

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SER 316

797-7189

### **Course Objectives**

- Understand and implement some important numerical methods used in computational physics.
- Gain confidence solving problems numerically using Fortran 90.

**Lecture:** Class will meet W/F in SER 122 at 9:00 AM – 10:15 AM

**Office Hours :** By Appointment

# Syllabus

**Homework:** Several **homework assignments** (5-6) will be given during the course of the semester that are due on specified due dates (at the beginning of the lecture). Homework must be received on time for full credit unless there is a valid excuse. The homework score will be proportional to the percentage of assigned problems turned in on time with substantial work done on them.

**Quizzes:** There will be **2-3 short quizzes** throughout the semester (mostly multiple choice)

**Midterm Exam:** There will be a **one-hour late midterm exam**. A page of useful formulas will be provided as well as numerical values of useful constants.

**Final Project:** There will be a **final project** toward the end of the semester.

**Final Grade:** Your letter grade will be assigned on the basis of a numerical distribution combining scores from exams, homework, quizzes, and a final project. The distribution will be determined using the following proportions:

Homework	40%
Late Midterm	30%
Final Project	20%
Quizzes	10%
Total	100%

## *Syllabus*

A percentage score will be computed for each student and the letter grade assigned according to the conversion table below:

Letter grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-
% score	92	90	88	82	80	78	72	70	68	62	60

The scores represent the lower bound for the adjacent letter grades. For example a B grade will be given for all aggregate % scores, weighted as described earlier, which fall between 82.0% and 87.9%. Marks below 60% will be graded F.

# *Syllabus*

## *I. Introduction*

- Accuracy in computing
- Fortran 90
- Local interpolation and cubic splines
- Definite integrals : trapezoidal rule, Romberg integration and adaptive integration

## *II. Ordinary Differential Equations (ODE's)*

- Linear and Nonlinear ODE's
- Initial value problems: Runge-Kutta and adaptive methods
- Boundary value problems: shooting and finite-difference methods

## *III. Partial Differential Equations (PDE's)*

Parabolic (diffusion), elliptic (Poisson), hyperbolic (wave/advection)

- Finite-difference and finite-element spatial discretization
- Explicit, semi-implicit and implicit time-stepping schemes
- Stability analysis

# *Syllabus*

**Official Text:** Lecture Notes and Handouts (on Canvas)

## **Reference Texts:**

### *Undergraduate texts*

- Introduction to Numerical Methods (Stark)
- Applied Numerical Analysis (Gerald & Wheatley)
- A First Course in Computational Physics (DeVries & Hasburn)
- Numerical Methods for Physics (Garcia)

## *Numerical Recipes*

[http://www.nr.com/  
oldverswitcher.html](http://www.nr.com/oldverswitcher.html)

### *Graduate Texts:*

- Introduction to Numerical Analysis (Stoer & Bulirsch)
- Numerical Recipes in Fortran 77 (Press, Teukolsky, Vetterling & Flannery)
- Numerical Recipes in Fortran 90 (Press, Teukolsky, Vetterling & Flannery)
- Computational Methods for Fluid Dynamics (Ferziger & Peric)

### *Fortran 90 References:*

- Upgrading to Fortran 90 (Redwine) best Fortran 90 reference
- Intro. to Fortran 90 (Nyhoff)
- An Intro. to Fortran 90 for Scientific Computing (Ortega)
- Intro. to Fortran 90/95 (Chapman)

# Useful FORTRAN 90 Reference

<http://www.docs.hp.com/en/B3908-90006/B3908-90006.pdf>

Link to the complete reference book in PDF-format.

This book has many good examples and a good list of the intrinsic functions available in Fortran 90.

**Best of all: It is free!**

# Essential Lahey FORTRAN 90 compiler

A great FORTRAN 90 compiler for Windows

Comes with graphical interface and editor

Educational Cost: \$25 (**now \$79**)

<http://www.lahey.com/elfpage.htm>

To buy look under

[http://store.tallactech.com/merchant2/merchant.mvc?Screen=SFNT&Store\\_Code=001](http://store.tallactech.com/merchant2/merchant.mvc?Screen=SFNT&Store_Code=001)

and go to *Products*

~~This compiler is also installed in **room 231** on the Dell PC~~

~~Login as User: **PHYX5350**~~

~~Click on: **Lahey ED Developer**~~

# gnu FORTRAN 90 compiler

A great FORTRAN 90 compiler is available free of charge from the gnu-project (Windows, Linux, MacOS).

**Does not come with graphical interface and/or editor**

**Use a CMD or DOS window, compiler is a command-line compiler**

<http://gcc.gnu.org/fortran/>

Look under *Binaries* --> Links to these can be found in the **wiki**

<http://gcc.gnu.org/wiki/GFortran#download>

Download

\* Binaries for Windows, Linux, MacOS and much more!

<http://gcc.gnu.org/wiki/GFortranBinaries>

mingw build, or "native Windows": download the latest **installer** (dated 2017/05/30).

Info on **how to run** the compiler: <http://gcc.gnu.org/wiki/GFortranBinariesWindows>



# **FORTTRAN 90/95 compiler from SilverFrost**

A good FORTRAN 90/95 compiler is available *free of charge* from SilverFrost (for personal use).

<http://www.silverfrost.com/11/ftn95/overview.asp>

**Click:** *To try the compiler click [here](#).*

[http://www.silverfrost.com/32/ftn95/ftn95\\_personal\\_edition.asp](http://www.silverfrost.com/32/ftn95/ftn95_personal_edition.asp)

You can download FTN95 Personal Edition (FTN95PE) version 8.10 [here](#).

**Install the compiler and use their graphical interface *Plato 3***