# 1060-710
# Mathematical and Statistical Methods for Astrophysics

Syllabus and Course Information – Fall 2009

2009 September 7

## Course Information

**Lectures:**
TÞ 16:00–17:45, 76-2155, beginning September 8 and ending November 12

**Instructor:**
Dr. John T. Whelan; 74-2063, 475-5083; `john.whelan@astro.rit.edu`
**Office Hours:** MW 09:00–10:50, or by appointment

**Course Website:** `http://ccrg.rit.edu/~whelan/1060-710/`

**Required Textbooks:**

- Arfken, G. B. and Weber, H. J., *Mathematical Methods for Physicists*, 6th edition (Elsevier, 2005)
- Gregory, P., *Bayesian Logical Data Analysis for the Physical Sciences* (Cambridge, 2005)

**Recommended Additional Texts:**

- Wall, J. V. and Jenkins, C. R., *Practical Statistics for Astronomers* (Cambridge, 2003)
- Wasserman, L., *All of Statistics: A Concise Course in Statistical Inference* (Springer, 2004)
- Sivia, D. S., *Data Analysis: A Bayesian Tutorial*, 2nd edition (Oxford, 2006)

**Other possibly useful references:**

- Matthews, J, and Walker, R. L., *Mathematical Methods of Physics*, 2nd edition (Addison-Wesley, 1970)
- Vaughn, M., *Introduction to Mathematical Physics* (Wiley, 2007)
- Byron, F. W. and Fuller, R. W., *Mathematics of Classical and Quantum Physics*, combined vols I and II (Dover, 1992)
- Dennery, P. and Krzywicki, A., *Mathematics for Physicists* (Dover, 1996)

**Prerequisites:**
Graduate standing in a science or engineering program or permission of instructor.

**Potential Topics:**

1 Mathematical Methods
   1.1 Differential Equations
   1.2 Green's Functions
   1.3 Numerical Methods
   1.4 Bessel Functions
   1.5 Spherical Harmonics

2 Fourier Analysis
   2.1 Fourier series, Fourier transforms, and discrete Fourier transforms
   2.2 Applications of the Fast Fourier Transform
   2.3 Spectral properties of random data

3 Statistical Inference
   3.1 Bayesian and frequentist approaches
   3.2 Central limit theorem and gaussian random variables
   3.3 Poisson processes and counting statistics
   3.4 Parameter estimation and errors
   3.5 Hypothesis testing and model selection

**Exams:**
One midterm exam on Mathematical Methods.
Non-cumulative final exam on Fourier Analysis and Statistical Inference.

**Homework:**
Quasi-weekly problem sets. and one or more longer-term projects. Problem sets will not be accepted after solution sets have been distributed.

**Course Listserv:** TBA.

All students will be expected to be subscribed to the course listserv from address which they read frequently, as organizational announcements may be sent there. Students are also encouraged to use the listserv to discuss concepts and issues related to the course.

I will also use the listserv to respond to student questions, so that the entire class can benefit from the exchange. If you email me a question which you don't want shared with the class, you must specify that explicitly in the email. (Similarly, if you want to ask a question anonymously, specify that you'd like your name left out of any reply posted to the listserv.)

# Course Policies

**Attendance:**
There is no attendance grade for the course, and no penalty for missing class. However, most students will find themselves at a disadvantage on the homeworks and exams if they neglect to take advantage of the full range of tools (including both lectures and reading) to gain understanding of the material.

**Exam Attendance:**
Makeup exams will only be granted in extreme circumstances. Unless you have a documentable emergency or an illness which requires medical attention, you should not expect to be able to make up a missed exam. If you do have a serious illness or emergency, please contact me as soon as possible.

**Class Disruptions:**
Please try to avoid disrupting the class by arriving late and/or leaving early. Please switch off all cell phones and beepers if possible. In case of an urgent need to be reachable during two hours of lecture (on-call EMT, critically ill loved one, etc.), please use silent/vibrate mode.

**Collaboration:**
Collective brainstorming is a time-honored tool of scientists attacking a problem, be they freshmen or tenured professors. That said, working through the homework problems is an important aid to gaining mastery of the material, and a student who simply transcribes the solution of another student or of the group will likely have trouble come exam time. In light of this, solutions which are clearly (in my judgement) transcriptions from other sources or from each other will receive reduced or no credit. You should use outside sources or group discussions as needed to get the idea of how to do a problem, then go off and write up your own solution.

Additionally, in the interest of learning proper academic procedures, you should acknowledge any outside help you get on homeworks, whether from other students or from references outside the textbook.

Working together on exams or copying off of someone else's test is of course cheating and will not be tolerated.

**Grades:**
Grades will be based on a linear combination of the overall homework grade, midterm exam grade, and final exam grade, each graded on the scale below. Your score on each component of the course (midterm exam, final exam, and all the homeworks together) will be converted to a numerical "grade point" score, and the weighted average of those four scores will be your final grade, converted to a letter grade according to the scale below. The weights for the final grade will be 40% homework, 30% midterm exam, and 30% final exam.

**Grading Scale:**

A 3.5–4.5
B 2.5–3.5
C 1.5–2.5
D 0.5–1.5
F (−0.5)–0.5

**Special Arrangements for Students with Disabilities:**
Students with disabilities who wish to receive accommodations in this class should contact the Academic Accommodations Office at 475-2023 or via their website http://www.rit.edu/studentaffairs/disabilityservices/academicaccommodations.php as soon as possible so that warranted accommodations can be implemented in a timely fashion. The Academic Accommodations Office is located in 01-2310.