Mathematical Physics
Syllabus, Spring 2017
Frank A. Moscatelli
Physics NYU

General Description

The course introduces important topics and methods in mathematics that are relevant to physics and engineering. Emphasis is on the use of the methods rather than on proofs and derivations. The assumed prior knowledge is three semesters of calculus or intensive calculus and at least one year of physics.

Instructor

Prof. Frank Moscatelli
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Teaching Assistant

Marc Williamson
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Meeting Times & Places

Lectures:	Tuesday Thursday 12:30 – 1:45	Meyer 102
Recitation:	Tuesday 2:00 – 3:15	Meyer 264
Recitation:	Thursday 2:00 – 3:15	Meyer 264

Texts

The required text is:
B. Kusse and E. Westwig, *Mathematical Physics*, 2006 (2nd ed), John Wiley & Sons

Other useful texts include:
George Arfken, *Mathematical Methods for Physics*
Mary Boas, *Mathematical Methods in the Physical Sciences*, 3rd Edition

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Weekly Problem Sets

Problem sets will be assigned about once a week and posted on NYU Classes. They are due Friday at 5:00PM in the (present) Physics office, Meyer 424. We require that your homework by typed (with special exemptions upon request) LaTeX is an essential skill in contemporary physics. The first recitation week will include LaTeX tutorials, as well as an uploaded example LaTeX files on NYU classes to help students transition from hand writing.

Exams

There will be two midterm exams and a final exam. The midterms will be announced well in advance. The final is scheduled by the Registrar.

Grading

Mid-term exam 1: 20%
Mid-term exam 2: 20%
Final exam: 30%
Homework: 30%

Topics

Vector Calculus, Tensors [Chapters 1 - 4]
- Summation Convention: Scalar, Vector Products, Determinants
- Gradient, Divergence, Curl, Gauss and Stokes Theorems
- Laplacian, Potential and Rotational Fields, Helmholtz Theorem
- Non-Cartesian Coordinate Systems, Introduction to Tensors, Eigenvalues, Eigenvectors

Dirac Delta and Complex Analysis [Chapters 5 - 6]
- Dirac Delta Function: singular distributions
- Complex Analysis: Analytic Functions, Derivatives, Cauchy Theorem
- Complex Analysis: Laurent Series, Residues, Residue Theorem, Contour Integrals

Differential Equations [Chapters 10 - 11]
- Ordinary Differential Equations: First Order, Second Order
- Frobenius Method, Legendre Polynomials, Fuch's Theorem, Bessel Functions
- Partial Differential Equations: Laplace, Diffusion and Wave Equations
- Special functions
    - Separation of Variables in Cartesian, Cylindrical and Spherical Coordinates.

Timeline*

Week 1. Scalars, vectors, matrices, summation convention. Ch 1**.
Week 2. Examples of vector operations and change of bases (Ch 4.3).
Week 3. Div, Grad, Curl in Cartesian coordinates and integral theorems. Ch 2.
Week 4. Div, Grad, Curl in non-Cartesian coordinates. Ch 3.
Week 5. Introduction to tensors, eigen-values and vectors. Ch 4.
Week 6. The Dirac delta function and other singular functions. Ch 5.
Week 7. Introduction to comlpex variables, differential calculus. Ch 6.1-3.
Week 8. Complex variables, integral calculus, series, residues. Ch 6 rest.
Week 9. Ordinary differential equations, first and second order. Ch 10.1-3.
Week 10. ODE solutions, series, quadrature, Greens functions. Ch 10 rest.
Week 11. Partial differential equations, Laplace's equation, Cartesian Ch 11.1-2.
Week 12. Laplace's equation in other coordinate systems. Ch 11.3-4.
Week 13. Buffer week
Week 14. Buffer and review.

*The above timeline is accurate with respect to the topics covered and their relevant sections in the chapters. The actual time spent on each topic must be considered an estimate, however. If I feel the class needs more time absorbing a particular subject, I will dwell on it longer. For that reason I included two "buffer" weeks.

** The chapter numbers refer to the required text.