# MATH PHYSICS

PHY 306 Instructor: Dr. Romulo Ochoa Science Complex - P132

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Text: "Mathematical Methods in the Physical Sciences," M. Boas (3rd Ed.)

### I. Course Description

A study of the mathematical methods used by experimental and theoretical physicists to solve a variety of physical problems. Topics include complex numbers, multiple integrals, curvilinear coordinates, matrix algebra, vector and tensor calculus, Fourier analysis, ordinary and partial differential equations, boundary value problems, special functions and advanced numerical techniques. Mathematica and/or Fortran will be used for both algebraic and numerical computations.

### II. Course Outline

Introduction to Mathematica. Survey of commands. Intro to Fortran. Homework: Mathematica challenges

1. Complex numbers.- (Ch. 2)

Complex plane. Complex algebra. Euler's formula. Powers and roots of complex numbers. The exponential and trigonometric functions. Logarithms. Homework problems: 4.14, 4.17, 5.9, 5.18, 5.23, 5.33, 5.46, 5.48, 10.9, 10.25, 11.5, 11.9, 11.16, 11.17

2. Linear equations; vectors, matrices, and determinants.- (Ch. 3)

Matrices, row reduction. Determinants; Cramer's rule. Vectors. Matrix operations. Linear Transformations. Eigenvalues and eigenvectors; diagonalizing matrices. Applications of diagonalization.

Homework problems: 2.4, 2.10, 2.12, 3.1, 3.4, 3.12, 3.13, 4.14, 4.16, 4.19, 4.23, 6.6, 6.13, 6.16, 6.17, 6.22, 7.22, 7.26, 7.32, 8.10, 8.12, 8.13, 8.23, 8.25, 9.4, 9.13, 9.14, 11.2, 11.12, 11.15, 11.27, 11.31, 12.3, 12.4, 12.15, 12.17.

3. Partial Differentiation.- (Ch. 4)

Total differentials. Chain rule. Implicit differentiation. Application to maximum and minimum problems. Lagrange multipliers. Homework problems: 1.9, 1.14, 1.21, 5.1, 5.7, 6.5, 6.10, 8.9, 8.10, 8.12, 8.16, 9.2, 9.6, 9.12.

Test 1

(TBA)

4. Multiple integrals; applications of integration.- (Ch. 5) Double and triple integrals. Applications of integration. Change of variables in integrals; Jacobians. Surface integrals. Homework problems: 2.5, 2.9, 2.15, 2.19, 2.23, 2.39, 2.47, 2.49, 3.7, 3.9, 3.17, 3.18, 4.7, 4.9, 4.16, 5.1, 5.8, 6.6, 6.12, 6.24, 6.27. 5. Vector analysis.- (Ch. 6)

Applications of vector multiplication. Triple products. Differentiation of vectors. Gradient. Line integrals. Divergence. Curl. Homework problems: 4.5, 4.6, 6.4, 6.5, 7.1, 7.13, 7.19, 8.1, 8.3, 8.11, 9.2, 9.11, 10.2, 10.4, 10.9, 11.3, 11.15.

6. Fourier Series and Transforms.- (Ch. 7)

Periodic functions. Application of Fourier series. Average value of a function. Fourier coefficients. Complex form of Fourier series. Even and odd functions. Fourier Transforms. Homework problems: 4.2, 4.5, 4.6, 5.1, 5.3, 5.8, 5.9, 5.11, 7.1, 7.11, 8.14, 8.16, 8.20, 9.6, 9.9, 9.11, 12. 4, 12.6, 12.10, 12.11, 12.18.

Test 2

#### (TBA)

7. Partial Differential Equations.- (Ch. 13)

Laplace's equation. Heat flow equation. Wave equation. Laplace's equation in cylindrical coordinates. Laplace's equation in spherical coordinates. Homework problems: 2.12, 2.15, 3.2, 3.3, 4.2, 4.3, 4.5, 5.8, 5.12, 5.13.

8. The Laplace Transform.- (Ch.8)

Integral transform. Solution of differential equations by Laplace transforms. Convolution. The Dirac delta function. Homework problems: 8.2, 8.6, 8.9, 8.21, 8.25, 9.3, 9.13, 9.23, 9.28, 9.40, 10.3, 10.9, 10.17, 11.7, 11.11, 11.23.

9. Tensor Analysis.- (Ch. 10)

Cartesian tensors. Tensor notation and operations. Inertia tensor. Kronecker delta and Levi-Civita symbol. Curvilinear coordinates. Vector operators in orthogonal curvilinear coordinates. Homework problems: 4.6, 4.7, 5.6, 5.7, 5.10, 9.16, 9.19, 9.21.

Final Exam

### **III.** Assessment of Student Performance

- 1. Tests (30 points)
- 2. Final exam (35 points)
- 3. Homework problems (35 points)

Grading Scale	
Final Score	Letter Grade
92.5 - 100	А
89.5 - 92.4	A-
86.5 - 89.4	B+
82.5 - 86.4	В
79.5 - 82.4	В-
76.5 - 79.4	C+

72.5 - 76.4	С
69.5 - 72.4	C-
66.5 - 69.4	D+
59.5 - 66.4	D
0-59.4	F

Homework problems are due one week after a chapter is completed. Late homework will not be accepted.

## **IV. Attendance**

Students are expected to attend class but if they choose not to this will have no negative effect on their grade. Students that do attend and participate or show effort in class may receive extra credit on their tests.

No makeup labs, tests, or exams will be given unless there is an emergency situation. In that case students are expected to contact the instructor no later than 24 hours after the missed lab or test; otherwise they will be given a zero grade for the missed evaluation.

TCNJ's attendance policy can be found at: http://www.tcnj.edu/~recreg/policies/attendance.html

# V. Academic Integrity Policy

Academic dishonesty is any attempt by the student to gain academic advantage through dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy *is available on the web:* <u>http://www.tcnj.edu/~academic/policy/integrity.html</u>.

## VI. Americans with Disabilities Act (ADA) Policy

Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571). Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992.

*TCNJ's Americans with Disabilities Act (ADA) policy is available on the web:* <u>http://www.tcnj.edu/~affirm/ada.html</u>.