

Selected Sections from: G B Arfken and H J Weber, Mathematical Methods for Physicists, 6th Edition, Elsevier Academic Press, ISBN 0-12-059876-0.

In PHY-5115 the selected material through Chapter 7 will be covered, and PHY-5116 shall cover (selected parts of) the remainder.

- 1 VECTOR ANALYSIS
 - 1.1 Definitions
 - 1.2 Rotation of coordinate axes
 - 1.3 Scalar product
 - 1.4 Vector product
 - 1.5 Triple products
 - 1.6 Gradient
 - 1.7 Divergence
 - 1.8 Curl
 - 1.11 Gauss' theorem
 - 1.12 Stokes' theorem
 - 1.15 Dirac delta function

- 2 CURVED COORDINATES AND TENSORS
 - 2.1 Orthogonal coordinates
 - 2.2 Differential vector operators
 - 2.5 Spherical polar coordinates
 - 2.6 Tensor analysis
 - 2.7 Contraction, direct product
 - 2.9 Pseudotensors, dual tensors
 - 2.10 Non-cartesian tensors

- 3 DETERMINANTS AND MATRICES
 - 3.1 Determinants
 - 3.2 Matrices
 - 3.3 Orthogonal matrices
 - 3.4 Hermitean matrices, unitary matrices
 - 3.5 Diagonalization of matrices

- 6 FUNCTIONS OF A COMPLEX VARIABLE I
 - 6.1 Complex Algebra
 - 6.2 Cauchy-Riemann Conditions
 - 6.3 Cauchy's Integral Theorem
 - 6.4 Cauchy's Integral Formula
 - 6.5 Laurant Expansion
 - 6.6 Singularities
 - 6.7 Mapping

- 7 FUNCTIONS OF A COMPLEX VARIABLE II
 - 7.1 Calculus of Residues

- 8 THE GAMMA FUNCTION
 - 8.1 Definitions, Simple Properties
 - 8.2 Digamma and Polygamma Functions
 - 5.9 Bernoulli Numbers, Euler-Maclaurin Formula [376]
 - 8.3 Sterling's Series

- 8.4 The Beta Function
- 8.5 The Incomplete Gamma Functions and Related Functions

- 9 DIFFERENTIAL EQUATIONS
 - 9.2 First-Order Differential Equations
 - 9.5 Series Solutions, Frobenius' Method
 - 9.6 A Second Solution

- 10 STURM-LIOUVILLE THEORY - ORTHOGONAL FUNCTIONS
 - 10.1 Self-Adjoint Differential Equations
 - 10.2 Hermitian Operators
 - 10.3 Gram-Schmidt Orthogonalization
 - 10.4 Completeness of Eigenfunctions
 - 10.5 Green's Function – Eigenfunction Expansion

- 11 BESSEL FUNCTIONS
 - 11.1 Bessel Functions of the First Kind
 - 11.2 Orthogonality
 - 11.3 Neumann Functions, Bessel Functions of the Second Kind
 - 11.4 Hankel Functions
 - 11.5 Modified Bessel Functions

- 12 LEGENDRE FUNCTIONS
 - 12.1 Generating Function
 - 12.2 Recurrence Relations and Special Properties
 - 12.3 Orthogonality
 - 12.5 Associated Legendre Functions
 - 12.6 Spherical Harmonics
 - 12.8 The Addition Theorem for Spherical Harmonics
 - 12.10 Legendre Functions of the Second Kind

- 13 MORE SPECIAL FUNCTIONS
 - 13.1 Hermite Functions
 - 13.2 Laguerre Functions
 - 13.3 Chebyshev Polynomials
 - 13.4 Hypergeometric Functions
 - 13.5 Confluent Hypergeometric Functions

- 14 FOURIER SERIES
 - 14.1 General Properties
 - 14.2 Advantages, Uses of Fourier Series
 - 14.3 Applications of Fourier Series
 - 14.4 Properties of Fourier Series
 - 14.6 Discrete Fourier Transform

- 15 INTEGRAL TRANSFORMS
 - 15.1 Integral transforms
 - 15.2 Development of the Fourier Integral
 - 15.3 Fourier Transforms - Inversion Theorem
 - 15.4 Fourier Transform of Derivatives
 - 15.5 Convolution Theorem

 - 15.8 Laplace Transforms
 - 15.9 Laplace Transforms of Derivatives

- 15.10 Other Properties
- 15.11 Convolution (Faltung) Theorem
- 15.12 Inverse Laplace Transform

16 INTEGRAL EQUATIONS

- 16.1 Introduction
- 16.2 Integral Transforms, Generating Functions
- 16.3 Neumann Series, Separable (Degenerate) Kernels
- 16.4 Hilbert-Schmidt Theory

17 CALCULUS OF VARIATIONS

- 17.8 Rayleigh-Ritz Variational Principle

EXAMS AND MORE

- Homework will be collected, but not graded. The fractional return on the homework will be assigned a score $H = 0 \dots 100$. Homework is due two weeks after assignment (not counting spring break). The deadline for homework submission is at the conclusion of the final exam.
- There will be three exams including the final. The length of each exam is the usual class period. Each exam score $E_i = 0 \dots 100$, $i = 1, 2, 3$, carries equal weight. The class textbook only is allowed, and required. Other materials are a calculator, a ruler, paper and pen(cil).
- The overall score X for the course is determined by combining homework and exams as

$$X = \frac{1}{2}H + \frac{1}{2} \frac{E_1 + E_2 + E_3}{3}.$$

- Tentative exam schedule, Fall 2009
Sep-30 (Wed)
Nov-04 (Wed)
Dec-07 (Mon)
- Announcements made in class may supersede syllabus rules!
- An approximate guideline for the grading scale is:

Points X	Grade
95–100	<i>A</i>
90–95	<i>A</i>
85–90	<i>A</i> –
80–85	<i>B</i> +
75–80	<i>B</i>
70–75	<i>B</i> –
65–70	<i>C</i> +
60–65	<i>C</i>
55–60	<i>C</i> –
50–55	<i>D</i> +
45–50	<i>D</i>
40–45	<i>D</i> –
0–40	<i>F</i>

HOMEWORK ASSIGNMENTS

1.2	(13)	1,2
1.3	(17)	3
1.4	(22)	7,9
1.5	(29)	5,7,13
1.6	(37)	1,3
1.7	(42)	3,5
1.8	(47)	7,8,11,14,17
1.11	(62)	2,3
1.12	(67)	1,10
1.15	(91)	1,7,13,23
2.1	(109)	2,3,6
2.2	(113)	3
2.5	(128)	1,6,8,16
2.6	(138)	2
2.7	(140)	2
2.9	(149)	3,4,12
2.10	(158)	2,5,6,8,15
3.1	(174)	1,2,3,6
3.2	(187)	1,4,5,7,11,13,15,36
3.3	(206)	1,6,9,10
3.4	(212)	1,5,12,13,16,18,20,24
3.5	(226)	3,6,8,10,19,30,33
3.6	(236)	1,5,16,17,18
6.1	(409)	8,10,16
6.2	(416)	2,5,7
6.3	(424)	3
6.4	(429)	2,4,8
6.5	(437)	3,8,9
6.6	(442)	2,4
6.7	(450)	1,4,6
7.1	(474)	1,5,11,14,27
8.1	(506)	4,5,11,25,26
8.2	(513)	7,8,13
5.9	(385)	2,7
8.3	(518)	3,4,9
8.4	(523)	14,16
8.5	(530)	7,8,10
9.2	(550)	2,3,6,10,12,16
9.5	(574)	1,5,7,12
9.6	(588)	3,4,10,11,15,21,23
10.1	(631)	3,6,12,13
10.2	(639)	3,7,9
10.3	(647)	3,6

10.4 (659) 4,5,9
10.5 (670) 2,8,11,13

11.1 (686) 2,10
11.2 (697) 2,9,10
11.3 (704) 1,2
11.4 (711) 3,4
11.5 (716) 1,6,10

12.2 (754) 2,5,7
12.3 (762) 2,6,11
12.5 (783) 5,11
12.6 (791) 2,4

13.1 (832) 3,9
13.2 (845) 3,9,12
13.3 (855) 1,3,30
13.4 (862) 1,6
13.5 (867) 12,15

14.1 (886) 2,3
14.2 (891) 1,3
14.3 (898) 1,9,14
14.4 (905) 2,9

15.1 (934) 1,2,4
15.3 (942) 1,5,10,17,18
15.4 (950) 3
15.5 (953) 5

15.8 (970) 1,2,4
15.9 (976) 1,2
15.10 (985) 5,11,13,16
15.11 (993) 1,2
15.12 (1000) 4,13

16.1 (1011) 1,6
16.2 (1015) 6,8
16.3 (1025) 1,2,4,11
16.4 (1034) 1,2,3,5

17.8 (1074) 2,4