Fall 2025.

Physics 501.
Methods of Theoretical Physics.

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Review problems

<u>You do not need to turn them in.</u> It is rather a guideline to help you to review undergraduate level topics you need to be familiar with. All solutions should be done analytically and with every detail of calculations.

1. **Mathematical Preliminaries. Arfken&Weber, Chapter 1.** Read the chapter. If you forgot anything, read the corresponding section more thoroughly. Do the basic exercises. Pay attention to infinite series, integration, and Dirac δ-finction.

2. **Determinants and matrices. Arfken&Weber, Chapter 2.** Read the chapter. If you forgot anything, read the corresponding section more thoroughly. Problems 2.1.8, 2.1.9; 2.2.3-2.2.9; 2.2.11, 2.2.12, 2.2.18, 2.2.35.

3. **Diagonalization of Matrices. Arfken&Weber, Chapter 6.** Read the chapter. If you forgot anything, read the corresponding section more thoroughly. Problems 6.2.1-6.2.12; 6.4.4-6.4.8.

4. **Differential Equations. Arfken&Weber, Chapter 7, Sections7.1-7.3.** Read the sections. For the second order differential equations recall your undergrad course of ODE or/and use any source of information you like.

1) Solve the differential equations:

a) $y' = (x - 1)^3$

b) $y' = y^2 - 3y + 2.$

2) Find a general solution for every linear differential equation:

a) $y' - 2xy = x;$

b) $xy' + y = \cos 4x;$

c) $y''' - y'' + y' - y = 0;$

d) $y'' - 2y' + y = 0$

e) $y'' + y = \sin 4x;$

f) $y'' + y = \cos x.$

3) Solve the initial-values problems:

a) $y'' + 16y = 0, y(0) = 1, y'(0) = 0$

b) $9y'' - 6y' + y = 0, y(0) = 1, y'(0) = 0$

4) Solve the boundary-values problems:

a) $y'' + k^2 y = 0, y(-a) = 0, y(a) = 0$

b) $y'' + k^2 y = 0, y(0) = 0, y(a) = 0$