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Mathematical Methods of Modern Physics - Problem Set 6

Summer Semester 2025

Due: The problem set will be discussed in the seminars on 19.05. and 20.05.

Internet: The problem sets can be downloaded from
https://home.uni-leipzig.de/stp/Mathematical_methods_2_ss25.html

1. Contour integrals I

4 Points

Calculate $\oint_C |z|^2 dz$, where C is a positively (i.e. counterclockwise) oriented circle of radius R and center $a \in \mathbb{C}$.

2. Contour integrals II

3+2+2 Points

Calculate $\int_C |z| dz$,

a) where C is a straight line connecting $-i$ to i.

b) where C is the left half of the unit circle connecting $-i$ to i.

c) where C is the right half of the unit circle connecting $-i$ to i.

3. Integrating the exponential function

2 Points

Show by direct contour integration for every path C from z_1 to z_2 that

$$\int_C e^z dz = e^{z_2} - e^{z_1} \ .$$

4. z^n on circular contour

2 Points

Calculate for all $n \in \mathbb{Z}$ by direct contour integration (i.e. not by using Cauchy's Integral Theorem) the integral

$$\int_C z^n dz \ ,$$

for C being a positively oriented circle of radius r centered around zero.