Institut für Theoretische Physik
Universität Leipzig

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Mathematical Methods of Modern Physics - Problem Set 1

Summer Semester 2025

Due: The problem set will be discussed in the first tutorials.

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

1. The field of complex numbers *5 Points*

The complex numbers are a field. Show that for any complex numbers the following relations hold:

a) $a + (b + c) = (a + b) + c$
b) $a \cdot (b \cdot c) = (a \cdot b) \cdot c$
c) $a \cdot b = b \cdot a$
d) For each complex number a except 0, there is one complex number b, such that $a \cdot b = 1$
e) $a \cdot (b + c) = a \cdot b + a \cdot c$

2. Cartesian and polar representation *5 Points*

Find the polar form of

a) $(1 + i)^2$
b) $(1 - i)^3$
c) $\frac{1-i}{2+2i}$

Find the cartesian form of

d) $e^{i\frac{\pi}{4}}$
e) $(2e^{i\frac{\pi}{8}}) \cdot (3e^{i\frac{3\pi}{8}})$

3. Complex roots *5 Points*

Find all complex solutions to

a) $z^5 = 1$
b) $z = (-8)^{\frac{1}{3}}$
c) $z = i^{\frac{1}{4}}$