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# Mathematical Methods of Modern Physics - Problem Set 1

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*Summer Semester 2024*

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

**Internet:** The problem sets can be downloaded from  
[https://home.uni-leipzig.de/stp/Mathematical\\_methods\\_2\\_ss24.html](https://home.uni-leipzig.de/stp/Mathematical_methods_2_ss24.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)  $z = i^{\frac{1}{4}}$