

Homework 4 Solutions

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The following solutions are based on the book *Mathematical Analysis for Engineers* (Springer, 2018) (link: <https://www.springer.com/9783319921000>).

1.1. Let $\{x_n\}_{n \in \mathbb{N}}$ and $\{y_n\}_{n \in \mathbb{N}}$ be arbitrary convergent series. Show that the series $\{x_n + y_n\}_{n \in \mathbb{N}}$ converges.

Solution: Since $\{x_n\}_{n \in \mathbb{N}}$ and $\{y_n\}_{n \in \mathbb{N}}$ converge, by Theorem 1.1.4, $\{x_n\}_{n \in \mathbb{N}}$ and $\{y_n\}_{n \in \mathbb{N}}$ converge to real numbers x and y , respectively.

$$\sqrt{(x_n + y_n)^2} = \sqrt{(x_n - x + x + y_n - y + y)^2} = \sqrt{(x_n - x)^2 + (y_n - y)^2 + 2(x - y)(x_n - x)} = |x_n - x| + |y_n - y|$$

By the Theorem 1.1.4 (triangle inequality), there exist $\{x_n\}_{n \in \mathbb{N}}$ and $\{y_n\}_{n \in \mathbb{N}}$ convergent absolutely, so we have $\{x_n + y_n\}_{n \in \mathbb{N}}$ converges absolutely, therefore converges to the correct sum.

1.2. Show the radius of convergence of $\sum_{n=0}^{\infty} x^n$ is 1 for every x . Show the convergence of the power series for the series $x = 0$ and $x = 1$.

Solution:
Let $\{x_n\}_{n \in \mathbb{N}}$ be the
from 1.1.4

$$\lim_{n \rightarrow \infty} \left| \frac{x_{n+1}}{x_n} \right| = \lim_{n \rightarrow \infty} \left| \frac{x^{n+1}}{x^n} \right| = |x|$$

so by the ratio test, the series converges absolutely for every series $|x| < 1$.

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so by the ratio test, the series converges absolutely for $|x| < 1$. For $x = 1$, the series $\sum_{n=0}^{\infty} 1^n$ diverges. For $x = -1$, the series $\sum_{n=0}^{\infty} (-1)^n$ diverges. For $x = 0$, the series $\sum_{n=0}^{\infty} 0^n$ converges to 1.

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Thomas Griffiths



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