# Econ Preparatory Math Course

## Ruhr Graduate School in Economics
## Fall 2024

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| **Advisor:** | Pavel Kocourek | **Classes:** | 10:00–15:00, LF 213 |
| **Email:** | pavel.kocourek@uni-due.de | **Office Hours:** | 16:00–17:00, LB 319a |

## Course Description

This intensive course equips new PhD students with essential mathematical skills for economics, covering key areas such as mathematical analysis, calculus, and linear algebra. It is designed to prepare students to explore more advanced or specialized mathematical topics independently. Additionally, the course fosters structured and analytical thinking, a crucial skill set for economic research.

Participation in the course and final exam is optional, but I encourage PhD students to take this opportunity to engage fully: participate in class, complete problem sets, and approach the final exam with dedication.

## Main Topics Covered

**Calculus and Analysis**

- Chapters 1–8 in Craw (2002)
- Chapters 13 and 14 in Simon et al. (1994)

**Optimization**

- Chapters 3.5 and 17 in Simon et al. (1994)

**Linear Algebra**

- Chapters 1–6 in Axler (2024)
- Supplementary resource: Cohen (2021)

**Metric Spaces**

- Chapters C.1–C.3 in Ok (2007)

**Introduction to Probability**

- Appendix A5 in Simon et al. (1994)

## Classes

Classes will take place in room LF 213 (Duisburg campus). The daily schedule is as follows:

- 10:00–12:00 – Class with a 15-minute break
- 12:00–13:00 – *Lunch break*
- 13:00–15:00 – Class with a 15-minute break

Classes will include a mix of lectures and practice sessions to reinforce key concepts and provide hands-on problem-solving experience.

## Office Hours

I will hold office hours from 16:00 to 17:00 on each day of the course, unless announced otherwise in class. My office, 319a, is on the 3rd floor of the LB building at Prof. Kovac's chair (room 317, the right door). Please feel free to drop by.

## Final Exam

The course will conclude with a final exam on **Wednesday, October 9th** in room LF 213:

- 10:00–12:00 – Exam

- 13:00–14:30 – Discussion of solutions and grading in pairs

The exam will be individual and open-book, but electronic communication, including LLMs or AI tools, is not allowed.

## Course Resources

Course materials, such as class notes, problem sets and practice exercises, will be posted on the course page: www.pkocourek.com/teaching/rgs-math-prep-2024

## How to Prepare for the Course

Since the course will be intensive, some preparation beforehand can help you get the most out of it. I recommend reading at least some of the book chapters listed in the course schedule. If you find these challenging, you may want to review the basics using "Essential Mathematics for Economic Analysis" by Sydsæter et al. (2016). For a deeper understanding of the fundamentals, Chapter 1 of De la Fuente and De La Fuente (2000) is also helpful.

## References

Axler, S. (2024). *Linear algebra done right*. Springer Nature.

Cohen, M. X. (2021). *Linear algebra: Theory, intuition, code*. Sl: Sincxpress Bv.

Craw, I. (2002). *Advanced calculus and analysis*.

De la Fuente, A. and De La Fuente, A. (2000). *Mathematical methods and models for economists*. Cambridge University Press.

Ok, E. A. (2007). *Real analysis with economic applications*, volume 10. Princeton University Press.

Simon, C. P., Blume, L., et al. (1994). *Mathematics for economists*, volume 7. Norton New York.

Sydsæter, K., Hammond, P. J., Strøm, A., and Carvajal, A. (2016). *Essential mathematics for economic analysis*. Prentice Hall.

## Schedule (preliminary)

### Week 1

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**Day 1** (Monday, September 23): *Introduction*

- Course introduction and overview
- Introductory test to assess baseline knowledge
- Basic concepts: real numbers, inequalities, intervals, functions, neighborhoods, etc.
- Introduction to proofs and mathematical logic

***Study Materials:*** Chapter 1 in Craw (2002), Appendix A.1 in Simon et al. (1994)

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**Day 2** (Tuesday, September 24): *Sequences*

- Sequences and criteria for convergence
- Limits and continuity

***Study Materials:*** Chapters 2–4 in Craw (2002)
***Assignment:*** *Problem Set 1*

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***Break*** (Wednesday, September 25) . . . time to solve *Problem Set 1*

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**Day 3** (Thursday, September 26): *Differentiability*

- Presentations of solutions of *Problem Set 1*
- Differentiability
- Infinite Series
- Power Series

***Study Materials:*** Chapters 5–7 in Craw (2002)

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**Day 4** (Friday, September 27): *Multi-variable Calculus*

- Continuity and differentiation of functions of several variables

***Study Materials:*** Chapter 7 and 8 in Craw (2002), Chapters 13 and 14 in Simon et al. (1994)
***Assignment:*** *Problem Set 2*

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***Weekend*** (September 28–29) . . . time to solve *Problem Set 2*

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**Week 2**

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**Day 5** (Monday, September 30): *Optimization*

- Presentation of solutions of *Problem Set 2*

- Minima and maxima of functions

- Fist– and second–order conditions

- Convexity, quasiconvexity, pseudoconvexity

***Study Materials:*** Chapter 3.5 and 17 in Simon et al. (1994)

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***Break*** (Tuesday, October 1)

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**Day 6** (Wednesday, October 2): *Linear Algebra 1*

- Vector spaces, bases, dimension

- Linear maps

***Study Materials:*** Chapters 1–3 in Axler (2024)
***Assignment:*** *Problem Set 3* (practice for the exam)

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***Break*** (Thursday, October 3) . . . time to solve *Problem Set 3*

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**Day 7** (Friday, October 4) *Linear Algebra 2*

- Eigenvalues and eigenvectors

- Inner product spaces

***Study Materials:*** Chapters 5–6 in Axler (2024)

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**Day 8** (TBD) *Selected Topics*

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