# **Course title:** *MA493/MA591 – Introduction to Hilbert Spaces*

**Instructor:** Patrick L. Combettes, plc@math.ncsu.edu

**Term:** Fall 2024

**Time:** Tuesdays and Thursdays, from 15:00 to 16:15

**Office:** SAS 3276

**Office hours:** Tuesdays and Thursdays, from 16:30 to 17:30 (or anytime by appointment)

**Prerequisite:** MA242, MA305 or equivalent

**Course objectives:** This course provides an introduction to the basic theory of Hilbert spaces and to some of its current applications.

**Course description:** Hilbert space theory constitutes the core around which most of modern analysis has grown, with a wealth of applications in areas such as variational analysis, differential equations, signal processing, machine learning, harmonic analysis, control, inverse problems, and statistics. A Hilbert space is a powerful extension of the basic notion of a Euclidean plane, from which it retains many intuitive concepts such as orthogonality, parallelogram and polarization identities, orthogonal coordinate decompositions, projections and best approximation concepts, as well as linear vector transformations.

**Content:** Vector spaces, scalar products, Hilbert spaces, projection theorem, orthonormal systems, orthonormal bases, Fourier series, linear operators on Hilbert spaces. Applications to differential equations, signal processing, optimization, physics, machine learning, inverse problems, and statistics.

**Grading:** Homework 30%, midterm exams 30%, final exam/project 40%.

**Reference material (no purchase necessary):**

- L. Debnath and P. Mikusinski, *Introduction to Hilbert Spaces with Applications*, 3rd. ed. Elsevier, 2000.
- N. Young, *An Introduction to Hilbert Space*. Springer, 1988.