

# MA5243 Advanced Mathematical Programming

## Course Syllabus: Fall 2024

<b>Lecture</b>	Lecture Theatre (LT) 33, 2:00 PM – 4:00 PM every Wednesday and Friday
<b>Instructor</b>	Shaoning Han Email: shaoninghan@nus.edu.sg Office hours: by appointment
<b>Grader</b>	Zhiyuan Ma Email: E0983565@u.nus.edu

- Reference Books**
- DIMITRI P. BERTSEKAS, *Nonlinear Programming*, Third Edition, Athena Scientific (2016).
  - MOKHTAR S. BAZARAA, HANIF D. SHERALI, AND C.M. SHETTY, *Nonlinear Programming: Theory and Algorithms*, Third Edition, John Wiley & Sons (2006).
  - JORGE NOCEDAL AND STEPHEN J. WRIGHT., *Numerical Optimization*, Fourth Printing, Springer (2006).
  - STEPHEN BOYD AND LIEVEN VANDENBERGH, *Convex Optimization*, Cambridge University Press (2004).
    - Available at: [web.stanford.edu/~boyd/cvxbook/bv\\_cvxbook.pdf](http://web.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf)

**Course Description:** MA5243 is a 4-unit course designed for Ph.D. students in mathematics. The goal of this course is to establish the mathematical foundations of general continuous optimization problems. It covers a variety of topics: Introduction to convex analysis; Optimality conditions; Lagrangian duality; Classical nonlinear programming algorithms including line search methods, Newton methods, trust-region methods, sequential QP, penalty, barrier and augmented Lagrangian methods; First-order methods for nonsmooth convex optimization problems. Most lectures are based on course notes. There is **no** required textbook, but homework assignments are drawn from reference books.

**Prerequisite:** There is no prerequisite required for graduate students. Undergraduates students must have completed MA3236 at a grade of at least A-; those who do not meet this prerequisite can seek departmental approval to enroll.

### Homework Assignments:

- There will be **four** homework assignments. Typically, all notifications including homeworks and their partial solutions will be announced on Canvas.
- All homework assignments are **due by 11:59am** on the date indicated. Late homework submissions are **not** accepted **under any circumstances**.
- Homework assignments must be submitted via **Canvas**. Only **one pdf file** should be submitted for each homework assignment. You can submit latex pdf files, word converted pdfs, or scanned images which are converted to pdf format.

### Grade Distribution:

- In-class exercise (10%)

- Homework assignments (25%)
- Midterm on **October 2** (30%)
- Final exam on **November 25** (35%)

### **Tentative Course Plan:**

- Convexity (4 lectures)
- Optimality conditions (2 lectures)
- Duality (4 lectures)
- Line search methods (1 lecture)
- Conjugate gradient methods and quasi-Newton-methods (2 lectures)
- Trust region methods (2 lectures)
- Penalty, barrier and augmented Lagrangian methods (2 lectures)
- Sequential quadratic programming (1 lecture)
- Nonsmooth convex optimization (5 lectures)

### **University policies**

- *Statement on Academic Integrity.* The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times. The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University. Students are referred to <https://www.comp.nus.edu.sg/cug/plagiarism> and <https://www.usp.nus.edu.sg/curriculum/plagiarism> for more detailed standards and policies on plagiarism & academic dishonesty.
- *Statement for Students with Disabilities.* NUS strives to provide an inclusive and nurturing campus environment for students with disabilities or accessibility needs to achieve their fullest potential. The Student Accessibility Unit (SAU) serves as a key touchpoint dedicated to supporting the range of access needs that students may have. The unit works closely with NUS offices and external partners to facilitate and provide individualised support services and resources to meet students' diverse needs. More guidance and information can be found at <https://nus.edu.sg/osa/orientation/resources/accessibility-support> and <https://osa.nus.edu.sg/services-support/accessibility-support/>. Contact email of SAU: [accessibility@nus.edu.sg](mailto:accessibility@nus.edu.sg).