# Summary of Part 2

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# Midterm Exam

Topics covered: Lectures 12–22

- problem sets 5–8
- practice questions published during the second part (the first is related to functions)

Material in the textbook

- Multivariate calculus; 12-15
- Optimization: chapters 16-19, 21-22, 30.1, 30.3
- note: in exam there will be no questions on topics not covered in the lecture and exercise material, e.g. no chapters 18.6, 19.1, 19.2, 19.5, 21.4, 21.5

# Review - Calculus of several variables

- Multivariate functions
- Continuous functions
- Open, closed, and compact sets
- Partial derivatives, gradient (and Jacobian)
- Chain rule
- Hessian matrix
- Implicit function theorem

# Review - Unconstrained optimization

- Local and global extrema (minimizers or maximizers)
- Weierstrass's Theorem
- First order conditions (for interior extrema)
- Second order conditions (for interior extrema)
- Quadratic forms
- Definite and semi-definite matrices
- Convex sets, concave and convex functions
- Monotone transformations

# Review - Constrained Optimization

Optimization problems with equality constraints:

- NDCQ
- first order necessary conditions
- second order sufficient conditions for local extrema

Optimization problems with inequality constraints

- NDCQ, first order necessary conditions
- concave problems
- second order sufficient conditions for local extrema

# Review - Some fundamentals

We have seen several propositions of the form “If $P$, then $Q$”

- We say that $Q$ is a **necessary condition** for $P$
- In more compact form, this is often indicated as $P \implies Q$, i.e. $P$ implies $Q$
- E.g., If the matrix $A$ is positive definite, then its diagonal entries are strictly positive

We've also seen propositions of the form “$P$ if and only if $Q$”

- In this case, we say that $P$ is both a **necessary and sufficient condition** for $Q$, and vice versa
- In more compact form, this is often indicated as $P \iff Q$, i.e. $P$ is equivalent to $Q$
- E.g., A function $f$ is concave if and only if its Hessian matrix is negative semi-definite

# Tips

You need to be able to differentiate the usual functions in economic models!

- linear and quadratic functions
- Cobb-Douglas (its gradient and Hessian)
- log-transformed Cobb-Douglas
- chain rule

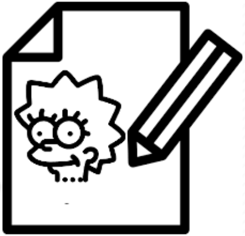
Understanding key concepts and theories

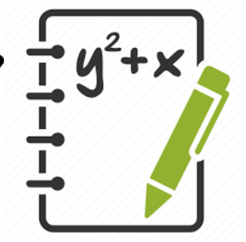
- implicit function theorem
- Weierstrass theorem
- role of concavity in maximization
- verifying the concavity of a function and the convexity of a set

First order conditions

- finding solutions
- be smart: utilize symmetry and monotonicity whenever possible

# Final Advice





# Advertisement

Mathematical Methods for Economics Research: Optimization
27.2.2024-18.4.2024

# Feedback

The ideas for the development of this course come from students!

- examples: recap of calculus, in-class exercises, format of TA sessions, ...
- please give feedback