

# Mathematics for Social Scientists II

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This series of lectures will present some of the ideas that form the foundation of quantitative work in the social sciences. In particular, topics from matrix theory and from calculus will be discussed with emphasis on the understanding of concepts and the development of intuition. The lectures assume some familiarity with the topics in the ICPSR course “Mathematics for Social Scientists I.” Both matrix theory and calculus problems, as well as their solutions, are provided in the coursepack found at <http://homepages.umflint.edu/~hmthomps/ICPSR/>. These problems enable the participant to evaluate his or her understanding of the material. The lectures may be supplemented by reading the following texts.

K. Namboodiri. *Matrix Algebra: An Introduction*. Sage Publications # 38, 1984.

D. Kleppner and N. Ramsey. *Quick Calculus*. Wiley, 1985.

## A. Matrix Theory (nine lectures)

Day 1            Introduction; matrices; matrix addition and subtraction; basic properties; scalar multiplication

Text: pp. 7 – 13  
Problems: # 1 - 6

Day 2            Vectors; the inner product; matrix multiplication

Text: pp. 13 – 23  
Problems: # 7 - 12

Day 3            Theorems concerning the basic matrix operations; the transpose

Text: pp. 23 – 27  
Problems: # 13 - 20

Day 4            Inverse of a matrix; the covariance matrix

Text: pp. 33 – 35  
Problems: # 21, 22, 23a, 24

Day 5            Elementary row operations; Gaussian elimination; properties of the inverse

Text: p. 29, pp. 35 – 41  
Problems: # 23bcd, 25 – 29

- Day 6            Rank of a matrix; systems of linear equations
- Text: pp. 53 – 64, pp. 70 – 74  
Problems: # 30 – 36
- Day 7            Trace of a matrix; linear dependence and independence of vectors
- Text: pp. 49 – 53  
Problems: # 37 – 40
- Day 8            The normal equations; the determinant of a matrix
- Text: pp. 41 – 46, pp. 74 – 78  
Problems: # 41 – 47
- Day 9            Eigenvalues and eigenvectors; principal components
- Text: pp. 79 – 94  
Problems: # 48 – 50

#### Additional References

- J. Gill. *Essential Mathematics for Political and Social Research*, Cambridge University Press, 2006
- E. Haeussler, R. Paul, R. Wood. *Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences*, 11<sup>th</sup> edition. Prentice-Hall, 2005.
- T. Hagle. *Basic Math for Social Scientists: Concepts*. Sage # 108, 1996.
- T. Hagle. *Basic Math for Social Scientists: Problems and Solutions*. Sage # 109, 1996.
- B. Noble and J. Daniel. *Applied Linear Algebra*. Prentice-Hall, 1988.
- S. R. Searle. *Matrix Algebra Useful for Statistics*, 3<sup>rd</sup> edition. Wiley, 1982.
- A. Tucker. *A Unified Introduction to Linear Algebra: Models, Methods, and Theory*. Macmillan, 1988.

## **B. Calculus** (nine lectures)

“F” stands for frame. Kleppner & Ramsey is divided into frames. “P” stands for problem. The problems are in the coursepack. “R” stands for review. The review exercises and answers to them are in Kleppner & Ramsey.

Day 1	Nonlinear functions; slope; average rate of change of a function  Text: F 1 – 39, F 116 - 129 Problems: P # 1 – 4, R # 1 – 3, 29, 32
Day 2	Limits; instantaneous rate of change of a function; the derivative; tangent line  Text: F 99 – 104, F 130 – 159, F 170 – 179 Problems: P # 5, 6, 7, R # 21, 33
Day 3	Differentiation theorems; intervals of increase and decrease of a function  Text: F 180 – 208, F 160 – 169 Problems: P # 8 – 10
Day 4	Concavity; inflection points  Text: F 242 – 245 Problems: P # 11, R # 34 - 37
Day 5	Maxima and minima of functions; exponents and logarithms  Text: F 250 – 259, F 75 - 95 Problems: P # 12 – 15
Day 6	Differentiation of exponential and logarithmic functions  Text: F 222 – 240 Problems: P # 16 – 18, R # 16 – 20, 51, 64, 67
Day 7	Partial Derivatives  Text: Appendix B3 Problems: # 19 – 21
Day 8	Antidifferentiation; indefinite integrals  Text: F 300 – 301, F 303 - 306 Problems: P # 22

Day 9            Definite integrals; Fundamental Theorem of Calculus, the Gini Index

Text: F 290 – 299, F 326 – 343, F 349 – 350

Problems: P # 23 – 26, R # 79, 86

Optional        Limited time does not permit a discussion of the trigonometric functions.  
However, during the last week we will have some “lunch meetings” for those  
interested in this topic.

Text: F 40 – 74, F 209 – 221, F 302, F 346 – 348

Problems: R # 8, 10, 40, 41, 45, 54, 66, 74, 83

### Additional References

J. Gill. *Essential Mathematics for Political and Social Research*, Cambridge University Press, 2006

L. Goldstein, D. Lay, and D. Schneider. *Calculus and Its Applications*, 10<sup>th</sup> edition. Prentice-Hall, 2004.

E. Haeussler, R. Paul, R. Wood. *Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences*, 11<sup>th</sup> edition. Prentice-Hall, 2005.

T. Hagle. *Basic Math for Social Scientists: Concepts*. Sage # 108, 1996.

T. Hagle. *Basic Math for Social Scientists: Problems and Solutions*. Sage # 109, 1996.

G. Iversen. *Calculus*. Sage # 110, 1996.