THE UNIVERSITY OF WISCONSIN-MILWAUKEE
Econ 458
Selected Topics in Economics
(Foundations of Econometrics)

Professor Chuan Goh

Fall 2016

1 Basic Information

- Lectures will be held on Tuesdays and Thursdays from 2:00 to 3:15 P.M.
- Lectures will meet in BOL B64, 3210 N. Maryland Ave.

2 Instructor Contact Information

- Professor Goh will hold office hours on Tuesday and Thursday afternoons between 12:50 and 1:50 in BOL 870, 3210 N. Maryland Ave. He is also available outside official office hours by appointment.
- He can also be reached by e-mail at `goh@uwm.edu`.

3 Course Description and Intended Learning Outcomes

This course covers foundational material from probability theory and mathematical statistics required for the study of econometrics at the Ph.D. level. This course

will also discuss statistical inference in the context of a linear model with strictly exogenous regressors.

This is a three-credit course. Students should expect to put in a minimum of six hours of study per week outside scheduled class meetings in order to achieve the learning goals of this course. Students should also note that a significant amount of self study will be required, particularly if their mathematical preparation is less than ideal. In particular, students are required to review and learn on their own time where necessary the material presented in the handout on mathematical background to be given out at the first class meeting.

4 Teaching Material

The only required textbook for this course is Fumio Hayashi (2000), *Econometrics*, Princeton University Press, ISBN 0-691-01018-8. Chapter 1 of this textbook will be covered toward the end of the semester.

There is no required textbook for most of the material covered in this course; course material will be presented in some detail in handouts that will be distributed at appropriate intervals during the semester.

The following is a list of (optional) textbooks that may be helpful in reinforcing course material as it is presented in class:

- (Probability theory) Kai Lai Chung (2000), *A Course in Probability Theory*, Second Revised Edition, Academic Press, ISBN 9780121741518
- (Matrix algebra) Shayle R. Searle (2006), *Matrix Algebra Useful for Statistics*, Wiley, ISBN 9780470009611
- (Mathematical statistics) George Casella and Roger L. Berger (2001), *Statistical Inference*, Second Edition, Duxbury, ISBN 9780534243128
- (Mathematical statistics) Keith Knight (1999), *Mathematical Statistics*, Chapman & Hall/CRC, ISBN 9781584881780
- (Mathematical statistics) Ramu Ramanathan (1993), *Statistical Methods in Econometrics*, Academic Press, ISBN 9780125768306

5 Prerequisites

Offically: junior standing and consent of the instructor. Unofficially: admission to the Ph.D. program in economics, or consent of the instructor. This course assumes prior exposure to statistics at an introductory undergraduate level as well as college-level calculus and linear algebra. Students should have had prior exposure to mathematical arguments and proofs.

6 Homework

Problem sets based on theoretical concepts covered in class will be assigned throughout the semester. **These assignments will not be graded**, but their completion will be essential for success on the examinations.

7 Grading Scheme

Student grades will be based on three components:

1. Midterm Examination 1 (M_1), Thursday October 20th, 2:00 –3:15 P.M., BOL B64: A test based on the material covered in class up to **October 13th**.

2. Midterm Examination 2 (M_2), Thursday November 17th, 2:00–3:15 P.M., BOL B64: A test based on the material covered in class from **October 18th to November 10th**.

3. Final Examination (F), Tuesday December 20th, 12:30 –2:30 P.M., BOL B64. This will be based on the material covered in class from **November 15th to December 13th**.

The final grade in this course will be determined by the average of the grades attained on M_1, M_2 and F.

8 Policies on Missed Examinations

Please read the following notices carefully:

1. **There will be no "make-ups" for missing any of the three examinations**. Students will receive a grade of zero for missing an examination unless they receive an accommodation from the instructor. Proper documentation will be required.

   Students who miss only one (1) examination and receive an accommodation will have their final grade determined as the average of the grades attained on the two examinations actually written.

   Students who miss more than one examination for any reason at all are strongly encouraged to take this course again at a later time.

2. Illness is the only generally acceptable reason for missing an examination. Students who are ill on the day of an exam should observe the following rules:

   (a) A note from a physician must be submitted to Professor Goh **within seven days** of the missed exam. This note must include the physician's full address in the form of a stamp, business card or official letterhead. The physician must also supply a daytime telephone number. A note that is missing any of this information will not be accepted.

   (b) The physician's note must establish that the student was examined and diagnosed at the time of the illness and not after the fact. A statement that merely confirms a report of illness made by the student for documentation by the physician will not be acceptable.

9 General University Policies

The UWM Faculty has adopted various general policies that govern the administration of this course. These policies are summarized on the document available at `http://www4.uwm.edu/secu/news_events/upload/Syllabus-Links.pdf`.
Among other items, these policies govern the granting of accommodations for students with disabilities.

10 List of Topics

The aim is to cover the following material in the following order.

Notes on self-study material:

- Sections 1.1–1.3 and 2.1–2.3 of Handout 0 should be read as soon as possible after the first lecture.
- Sections 1.4–1.17 of Handout 0 should be read prior to encountering the material on transformations of multivariate distributions discussed in Handout 2.
- Sections 1.18 and 1.19 of Handout 0 should be read no later than the first lecture of Econ 734.

- The entirety of Sections 2 and 3 of Handout 0 should be read prior to encountering the material on characteristic functions presented in Sections 2.7.2 and 2.7.3 of Handout 1.
- Students should familiarize themselves by the middle of November with the most popular families of probability distribution encountered in statistics. This material can be found in all introductory graduate textbooks in statistics. See e.g., Sections 3.2 and 3.3 of the textbook by Casella and Berger.

1. Foundations: September 6, 8, 13, 15, 20, 22
   (a) Algebras and sigma-algebras (general properties, Borel sets)
   (b) Properties of probability measures
   (c) Uniform probability measure (outer measure, extension of outer measures)
   (d) Lebesgue measure and Lebesgue integration
   (e) Random variables and random vectors and their distributions
   (f) Density functions
   (g) Conditional probability (definitions, Bayes' rule, independence)

   Read Handout 1, Section 1
2. Expectations: September 27, 29; October 4
   (a) Borel measurability
   (b) Integrals of Borel-measurable functions with respect to a probability measure
   (c) Integrals of random variables with respect to a probability measure
   (d) Mathematical expectation
   (e) Inequalities involving expectations
   (f) Expectations of products of independent random variables
   (g) Generating functions (moment-generating functions, characteristic functions)

   Read Handout 1, Section 2
3. Conditional expectations: October 6, 11, 13
   (a) Properties of conditional expectations
   (b) Conditional probability measures and conditional independence
   (c) Conditioning on an infinite sequence of sigma-algebras
   (d) Conditional expectations as best forecast schemes

   Read Handout 1, Section 3
4. Transformations of random variables and special distributions: October 18
   (a) Distributions of functions of a random variable

(b) Commonly encountered discrete distributions

(c) Commonly encountered continuous distributions

Read all of Handout 2

5. Multivariate normal distribution theory: October 25, 27; November 1, 3, 8

   (a) Expectation and variance of random vectors

   (b) Multivariate normal distribution

   (c) Conditional distributions of multivariate normal random vectors

   (d) Independence between linear and quadratic transformations of multivariate normal random vectors

   (e) Distributions of quadratic forms of multivariate normal random vectors

   Read all of Handout 3

6. Statistical inference for normal populations: November 10

   (a) Point estimation

   (b) Confidence intervals

   (c) Hypothesis tests

   Read all of Handout 4

7. Linear regression with strictly exogenous regressors: November 15, 22, 29; December 1, 6, 8, 13

   (a) "Classical" linear regression

   (b) Ordinary least squares

   (c) Hypothesis tests with spherical normal errors

   (d) Maximum likelihood estimation of linear regression models with spherical normal errors

   (e) Generalized least squares

   (f) Conditional expectations and linear prediction

   (g) Empirical example: Returns to scale in electricity supply

   Read Hayashi, Chapter 1 and all of Handout 5
   Read Handout 6