AFRICAN ECONOMIC RESEARCH CONSORTIUM

COLLABORATIVE MASTERS DEGREE PROGRAMME (CMAP) IN ECONOMICS FOR SUB-SAHARAN AFRICA (EXCEPT NIGERIA)

QUANTITATIVE METHODS

COURSE OUTLINE

(Revised: February, 2014)

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1. INTRODUCTION

1.1 Objectives

This course aims to provide a sound training in mathematics and econometrics which masters student in economics would be expected to cover. The structure of the course takes into account past experience in offering the course within the collaborating universities as well as recent developments. The structure also conforms to the prevailing trends in reputable Universities across the globe.

The curriculum is designed to improve the quantitative skills of master's students in economics. More specifically, the objectives of this course are to equip students to be able to:

- read and understand arguments in textbooks and journal articles using mathematical techniques commonly used in modern economic analysis;
- grasp the relevance and use of modern mathematical techniques in their applications in theoretical and applied economics;
- apply standard quantitative techniques to the analysis of economic phenomena and to conduct empirical research;
- develop models in theoretical or applied work; and
- understand the theoretical foundations of quantitative techniques.

1.2 Prerequisites

Knowledge and understanding of basic mathematics and statistics at the undergraduate level

1.3 Organization and mode of assessment

The course is divided into two parts each running for one semester with 60 contact hours per semester. The assessment of the course will be through course work, project and final examination.

2. PART I: MATHEMATICS

2.1 Overview

This part of the course puts emphasis on the teaching of mathematical techniques and programming required for a standard master's level economic analysis, but not on mathematical economics as a specialized branch of economics. This should not bar a department or the collaborative programme as a whole from offering an elective course in advanced mathematical economics should it be desired.

2.2 Textbooks

The course curriculum is designed around the following textbooks:

A.C. Chiang and K. Wainwright (2005): *Fundamental Methods of Mathematical Economics (*4th Edition), McGraw-Hill.**(CW)**

K. Sydsæter and P. Hammond (2006), *Essential Mathematics* for *Economic Analysis,* Prentice Hall.**(SH)**

K. Sydsæter, P. Hammond, Atle Seierstad and Arne Strøm (2005), *Further Mathematics for Economic Analysis*, Prentice Hall. **(SHSS)**

M.W. Klein (1997) *Mathematical Methods for Economists*, Addison-Wesley: Reading-Massachusetts.

Simon, C.P., and L. Blume, (1994), *Mathematics for Economists*, Norton.

These particular textbooks were chosen because they treat mathematical techniques at progressively higher levels of difficulty, each time indicating whether the material is pitched at the BA, MA, or Ph.D level. The texts are particularly suited to achieve two purposes: (1) to teach mathematics for economists at the appropriate level, and (2) to allow students to revise through self-study the prerequisites of the different components of the course.

2.3 Course Content

The course comprises of the following four parts: Matrix algebra, economic applications of calculus and static optimization, dynamic analysis and optimization, and introduction to set theory and real analysis.

I MATRIX ALGEBRA *12 hours*

This section features elements of revision of components of bachelor's level training in matrix algebra. The emphasis in this part is on the solution of simultaneous equations.

Prerequisites: self-study individual readings: *Klein, Chapter 4: 4.2 and 4. 3*

1.1. Matrix algebra and system of linear equations ***4 hours***

Reading: Klein, Chapter 4
CW, Chapters 4 and 5
SH, Chapters 15 and 16

1.2. Solving system of linear equations with economic applications, including the input-output model ***4 hours***

Reading: Klein, Chapter 5
CW, Chapters 4 and 5
SH, Chapters 15 and 16

1.3. Eigenvalues and eigenvectors ***2 hours***

Reading: CW, Chapters 4 and 5
SHSS, Chapter 1

1.4. Quadratic forms ***2 hours***

Reading: CW, Chapters 4 and 5
SHSS, Chapter 1

II ECONOMIC APPLICATIONS OF CALCULUS AND STATIC OPTIMIZATION ***21 hours***

This section revises differential and integral calculus with specific emphasis on their applications to economic analysis. Although students are assumed to be familiar with univariate calculus, some applications will be reviewed. The main emphasis is on multivariate calculus, extreme values of multivariate functions and constrained optimization.

Prerequisites: Self-study individual readings: *Klein, Chapters 6 and 7*

2.1 Univariate differential calculus ***3 hours***

2.2 Applications of univariate optimization ***2hours***

Readings: Klein, Chapters 7 and 9
CW, Chapters 6, 7, 9 and 10
SH, Chapters 6-8

2.3 Applications of multivariate differential calculus ***5 hours***

2.4 Applications of extreme values of multivariate functions ***5 hours***

Readings: Klein, Chapter 8
CW,Chapters 8 and 10
SH,Chapters 11-13
Klein, Chapter 10

2.5 Applications of unconstrained optimization ***2 hours***

Readings: Klein, Chapter 11
SH, Chapters 14 and 17
CW, Chapters 12 and 13

2.6 Applications of integral calculus ***4 hours***

Readings: CW, Chapter 14
SH, Chapter 9

III DYNAMIC ANALYSIS AND OPTIMIZATION ***22 hours***

This section introduces material on dynamic optimization which in part will be new to most students. It concerns difference and differential equations and dynamic optimization. Particular attention should be given to the economic applications of the techniques rather than their mechanics.

Prerequisites: Self-study individual readings: Klein, Chapter 12

3. 1 Dynamic analysis

3.1.1 Applications of difference equations ***6 hours***

Readings: Klein, Chapter 13
CW, Chapters 17 and 18

3.1.2 Applications of differential equations ***6 hours***

Readings: Klein, Chapter 14
CW, Chapters 15 and 16

3.2 Applications of dynamic optimization

10 hours

3.2.1 Dynamic optimization in discrete time

3.2.2 Optimal control theory

3.2.3 Calculus of variations

Readings: Klein, Chapter 15
CW, Chapter 20

IV INTRODUCTION TO SET THEORY AND REAL ANALYSIS ***5 hours***

4.1 Set theory ***3 hours***

Readings:

Simon and Blume, Chapter 12

4.2 Real analysis ***2 hours***

Readings:

Simon and Blume, Chapters 15, 20 and 21

3. PART II ECONOMETRICS

3.1 Overview

This part of the course aims to provide a sound training in the theory and practice of modern econometrics. To this end, matrix algebra is introduced progressively, after students have become acquainted with the non-matrix formulations. A rigorous and fully-fledged matrix algebra treatment of econometrics is provided in a subsequent elective course on econometric theory and practice.

3.2 Textbooks

Hill R. C., W.E. Griffiths and G.C. Lim (2011), *Principles of Econometrics*, Wiley (4th Edition) **(HGL)**

Wooldridge, J. M. (2013), *Introductory Econometrics: A Modern Approach*, (5th Edition), Cengage Learning

Supplementary text books

Adkins, L. C. (2013) *Using GRETL for Principles of Econometrics*, (4th Edition), Free online textbook

Adkins, L. C. and Hill (2008) *Using Stata for Principles of Econometrics***,** Stata Press

Baltagi, B. (2011) *Econometrics* (5th Edition), Springer

Greene W. H. (2011), *Econometric Analysis* (7th Edition), Prentice Hall.

Gujarati D. N. and D. C. Porter (2009), *Basic Econometrics* (5th Edition), McGraw Hill.

Harris, R. and R. Sollis (2003), Applied Time Series Modelling and Forecasting, Wiley.

Johnston, J. and J. DiNardo (1997), *Econometric Methods*, McGraw-Hill 4th Ed.**(JD)**

Maddala, G. S, and K. Lahiri (2010) *Introduction to Econometrics* (4th edition), Wiley

Maddala, G.S. (1985), *Limited Dependent and Qualitative Variables in Econometrics***,** Cambridge University Press, New York.

Mukherjee, C., H. White and M. Wuyts (1998), *Econometrics and Data Analysis for Developing Countries*, Routledge: London (with data diskette).

Verbeek, M. (2013), *A Guide to Modern Econometrics* (4th Edition), Wiley.

Woodward, W. A, H. L. Grey and A. C. Elliott (2011), *Applied Time Series Analysis*, CBC Press

Wooldridge J.M (2010), *Econometric Analysis of Cross Section and Panel Data*, MIT Press

Additional econometrics resources are available at http://econometricslinks.com. and http://www.economicsnetwork.ac.uk/

3.3 Software

Since the course requires computer-assisted laboratory sessions, it is recommended that students be trained in econometric software packages that are appropriate, not only for econometric applications, but also for modern data analysis (e.g., using graphical methods).

Mathematics for economists software: Mathematica, Maxima (open source available at http://maxima.sourceforge.net/)

Econometrics software: *STATA and Eviews* are *highly* recommended statistical packages which are excellent for modern data analysis as well as for standard econometric applications (including time series analysis). Open source alternatives are GRETL (http://gretl.sourceforge.net/), R (http://www.r-project.org/) and OCTAVE (https://www.gnu.org/software/octave/). Other recommended commercial statistical packages include RATS, LIMDEP, MICROFIT, MATLAB, GAUSS and SHAZAM. Note that, at the start of the course, students need to be given an introduction to the appropriate software package.

3.4 Course content

I REVIEW OF PROBABILITY AND STATISTICS ***8 hours***

This part assumes that students are already familiar with basic statistical inference in the univariate case. These techniques are simple in construction, powerful for empirical analysis, but are largely unknown to students with a more traditional training in statistics for economists. This part requires a combination of lectures and computer-assisted hands on experience with real data.

Prerequisites: self-study individual readings: Wooldridge (2013), Appendices B and C)

1.1. Fundamentals of Probability ***2 hours***

Readings: Wooldridge (2013), Appendix B
Verbeek, Appendix B
HGL, Appendix B

1.2. Estimation (least squares, method of moments and maximum likelihood) ***4 hours***

Readings: Wooldridge (2013), Appendix B

1.3. Hypothesis testing ***2 hours***

Readings: HGL, Appendix C

II CLASSICAL LINEAR REGRESSION ***12 hours***

This part largely contains revision of material that students should already be familiar with, although some of the later topics may not have been covered in some undergraduate programmes. The emphasis of this section should be on stochastic explanatory variables and the problem of non-spherical disturbances. Computer-assisted laboratory sessions with real data are encouraged.

Prerequisites: self-study individual readings: HGL, Chapters 1 - 4

2.1 The classical (multiple) regression model ***3 hours***

Readings: Wooldridge (2013), Chapters 3-6
HGL, Chapter 5
Verbeek, Chapter 2

2.2 Restricted least squares

2.3 Relaxing classical assumptions (including stochastic explanatory variables), ***6 hours***

Readings: Wooldridge (2013), Chapters 8 and 12
HGL, Chapter 8 and 9
Verbeek, Chapters 3 and 4

2.4 Model selection ***3 hours***

Readings: HGL, Chapters 6 and 7
Gujarati and Porter, Chapter 13
Verbeek, Chapter 3

III SIMULTANEOUS EQUATION MODELS ***8 hours***

This part introduces simultaneous equation models **(**SEMs). The aim is to provide examples of SEMs and show why the method of ordinary least squares (OLS) is generally inapplicable owing to endogeneity and simultaneity bias.

3.1 Specification, identification and simultaneity bias ***4 hours***

Readings: HGL, Chapter 11
Verbeek, Chapter 5

3.2 Estimation techniques (ILS, 2SLS, etc.) ***4 hours***

Readings: HGL, Chapters 9 and 14
Verbeek, Chapter 5
Gujarati and Porter, Chapters 18-20

IV TIME SERIES ANALYSIS ***16 hours***

This part aims to familiarize students with the basic concepts in time series analysis and the empirical analysis of time series data. It should include at least one computer-assisted hands on experience laboratory session investigating deterministic and stochastic trends in time series and estimating a dynamic model.

4.1 Specification and estimation of univariate time series models ***4 hours***

Readings: JD, Chapter 7
Verbeek, Chapter 8
Enders, Chapter 2

4.2 Estimation of ARDL and related models ***2 hours***

Readings: HGL, Chapter 9
Gujarati and Porter, Chapter 17

4.3 Trends, unit roots and spurious regressions ***3 hours***

Readings: HGL, Chapter 12
Verbeek, Chapter 8
Gujarati and Porter, Chapter 21
Enders, Chapters 2 and 4
Harris and Sollis, Chapter 3

4.4 Cointegration and error-correction models ***3 hours***

Readings: HGL, Chapter 12
Verbeek, Chapter 9

Enders, Chapter 6

Harris and Sollis, Chapter 4

4.5 VAR models ***2 hours***

Readings: HGL, Chapter 13

Gujarati and Porter, Chapter 22

Enders, Chapter 5

Verbeek, Chapter 10

Harris and Sollis, Chapters 5 and 6

4.6 Introduction to ARCH and GARCH models ***2 hours***

Readings: HGL, Chapter 14

Enders, Chapter 5

Verbeek, Chapter 8

Harris and Sollis, Chapter 8

4.7 Forecasting ***2 hours***

Readings: HGL, Chapters 9 and 14

Gujarati and Porter, Chapter 22

Enders, Chapter 2

Harris and Sollis, Chapter 8

V LIMITED DEPENDENT VARIABLE MODELS ***8 hours***

This part deals with qualitative and limited dependent variables. It should be supported by one or more computer-assisted laboratory sessions using a cross-section data featuring various categorical variables.

5.1. Linear probability models, logit and probit ***4 hours***

Readings: HGL, Chapter 16

Gujarati and Porter, Chapter 15

Madalla and Lahiri, Chapter 8

Wooldridge (2013), Chapter 7

Verbeek, Chapter 10

5.2 Tobit and sample selection ***4 hours***

Readings: HGL, Chapter16
Gujarati and Porter, Chapter 15
Madalla and Lahiri, Chapter 8
Wooldridge (2013), Chapter 17
Verbeek, Chapter 10

VI PANEL DATA ANALYSIS ***8 hours***

This part introduces models that combine time series and cross-sectional observations, and the methods by which they can be estimated.

6.1. Pooled, fixed effects and random effects regressions ***6 hours***

Readings: HGL, Chapter 15
Gujarati and Porter, Chapter 16
Verbeek, Chapter 10
Wooldridge (2013), Chapters 13-14

6.3 Specification tests ***2 hours***

Readings: HGL, Chapter 15
Gujarati and Porter, Chapter 16
Verbeek, Chapter 10
Wooldridge (2013), Chapters 13-14