



FACULTY OF SOCIAL SCIENCES

*Applied Statistics with Network Analysis (MASNA) Program*

**Linear Models I Course Syllabus**

**Professor:** TBD  
**Office:** TBD  
**Office Hours:** TBD  
**Email:** TBD

**Class Hours:** TBD

**Text & Materials**

**1. Required readings:**

Covering most of the topics, with some calculus and proofs

- R.A. Gordon Regression analysis for the social sciences. Routledge, 2015.
- M.H. Kutner et al. Applied Linear Statistical Models. McGraw-Hill, 2005.
- J. Fox Applied Regression Analysis and Generalized Linear Models. SAGE, 2015.
- S. Weisberg Applied linear regression. Wiley, 2005.
- R.B. Darlington, A.F. Hayes Regression analysis and linear models: Concepts, applications, and implementation. Guilford Press, 2016.
- Pardoe Applied regression modelling. Wiley, 2012.

**2. Optional readings:**

Brief description of main topics

- L.D. Schroeder, D.L. Sjoquist, P.E. Stephan Understanding regression analysis:
- An introductory guide. SAGE, 2016.
- C. Lewis-Beck, M. Lewis-Beck Applied regression: An introduction. SAGE, 2015.

Advanced mathematical treatment of Linear Models

- J.H. Stapleton Linear statistical models. Wiley, 2009.
- J. Gross Linear Regression. Springer, 2012.
- D.J. Olive Linear Regression. Springer, 2017.
- J.O. Rawlings et al. Applied Regression Analysis: a Research Tool. Springer, 2001

3. There are some additional readings that you are responsible for throughout the semester; they will be handed out, as necessary, during the course.
4. Software: you will be required to learn SAS. We will start from scratch with a crash course in SAS, and additional assignments throughout the semester will help you master the software.

**I. Course Summary**

This course is an introductory course in linear models, designed to familiarize graduate students with the general concepts and basic techniques of the role of linear models in applied statistics. After a review of fundamental concepts in statistics (e.g., issues of measurement, probability, estimation, and hypothesis testing), we will turn our attention to regression analysis, including variable selection, model diagnostics,

remediation, and validation. Computers are a fundamental tool of modern statistical analysis; thus, students will learn the computing methods and data analysis techniques necessary to apply statistical concepts during weekly computer lab sessions, which will be handled in SAS. By the end of this course, students are expected to be able to identify and carry out appropriate statistical analyses, and to interpret results both statistically and in context.

## II. Course Overview & Objectives

The goal of the course is ensure that students understand topics and principles of applied linear models, basic level. Therefore, the course is designed:

- To provide students with an understanding of the basic principles of linear models and lay the foundation for future learning in the area.
- To explore the advantages and disadvantages of various linear modeling instruments, and demonstrate how they relate to other methods of analysis.
- To develop student familiarity, through hands-on experience, with the major linear modeling programs, especially SAS, so that they can use them and interpret their output.
- To develop and/or foster critical reviewing skills of published empirical research using applied statistical methods.

### The Course develops the following competencies

Competencies	NC/NRU-HSE Code	Descriptors - the learning outcomes (the indicators of achievement)	Teaching forms and methods of that contribute to the development of a competence
<b><u>Systemic Competencies</u></b>			
1. Ability to reflect (evaluate and reprocess) studied scientific methods and techniques of professional activity.	CK-1	Can evaluate and reprocess methods and techniques of contemporary data analysis for a given problem.	Lectures, readings, in-class exercises, data analysis projects
2. Ability to create new theories, invent new techniques and tools of professional activity.	CK-2	Can use their knowledge in contemporary data analysis to create new theories, invent new techniques and tools of professional activity.	Lectures, readings, in-class exercises, data analysis projects
3. Ability to independently learn new research methods, change the scientific and production profile of their activity.	CK-3	Can use new methods and techniques of contemporary data analysis, additional packages and tools, without direct supervision.	Lectures, readings, in-class exercises, data analysis projects
4. Ability to analyze, verify, evaluate the completeness of information in the process of their professional activities, to	CK-6	Able to analyze, verify, evaluate the completeness of information, can integrate information found	Lectures; independent work.

Competencies	NC/NRU-HSE Code	Descriptors - the learning outcomes (the indicators of achievement)	Teaching forms and methods of that contribute to the development of a competence
replenish and synthesize missing information, if necessary.		from various sources and compensate for lack of data by adjusting models.	
<b><u>Social and Personal Competencies</u></b>			
5. Ability to determine and transmit common goals in professional and social activities.	ПК-4	Can effectively determine and transmit common goals in professional and social activities.	In-class exercises, data analysis projects
6. Ability to analyze and reproduce the meaning of interdisciplinary texts using the language and apparatus of applied mathematics.	ПК-10	Can understand and concisely reproduce the interdisciplinary texts with the usage of language and apparatus of applied mathematics.	Lectures, readings, in-class exercises, data analysis projects
7. Ability to create, describe and responsibly control the implementation of technological requirements and regulatory documents in professional activities.	ПК-15	Can create technological requirements and regulatory documents related to professional activities. describe them to others and control their implementation.	Lectures, readings, in-class exercises, data analysis projects
8. Able to understand and apply modern mathematical tools in research and applied activities.	ПК-18	Can effectively apply different modern mathematical tools in research and applied activities.	Lectures, readings, in-class exercises, data analysis projects

**This course will emphasize advance preparation for each class period and will involve a high level of class participation.** Often, experiential exercises and simulations will be used to illustrate key network analysis concepts. While I do not take attendance, missing classes on a regular basis will be detrimental to your learning.

**Teaching Format**

This is an interactive, participatory course. The course will be run mainly as a combination of lectures, small group discussions, and in-class exercises. In order to have good discussions of the course materials, students must come prepared for class. This means having **read the assigned reading materials before class and coming prepared to discuss the readings and ask questions.**

**Lectures**

Lectures are an integral part of this course, and they consist of two parts: the material I present in class and a slide deck with many more details (which we do not have time to go over in class). The slide deck, in many cases, is almost sufficient for you to master the material. In other words, if you read and understand *everything* in the slide deck, the assigned reading will only solidify the material further, but may not be required to do well in class. If you have issues with what is written in the slide deck, then the assigned reading material is essential – you must read and go through every minute detail, or you are highly unlikely to succeed.

### III. Requirements and Evaluation Criteria

#### Grades

Course grades will be computed as follows:

Course Element	% Towards Final Grade
Final Exam	<b>50%</b>
<i>Final In-Class or Take-home exam (at the discretion of the instructor)</i>	50%
Participation and responsibility grade	<b>50%</b>
<i>Homework Assignments (5 x Varied points)</i>	20%
<i>In-Class Labs (9-10 x Varied points)</i>	20%
<i>Quizzes (Best 9 of 10, Varied points)</i>	10%
Extra credit	As assigned
Total	100%

#### **Grading Scale, Rounding, and Curves:**

Your grade is the grade you *earn*. There is no curve imposed in this class.

I prefer to hear your concerns about grading during the semester. **Do not wait until the end of the semester to see me regarding problems with course materials or your performance (it will be too late to address deficiencies at the end of the semester)**. If you are aware that you must achieve a particular grade in this course, please see me during the first week of the course. This will allow me to alert you of deficiencies in your performance. There is nothing that either of us can do at the end of the course.

**Extra-credit:** I firmly believe that education does not start and end with the required course material. Very often, what you remember the most from the course does not come from a book, but perhaps from a wise comment by a peer, a clever exercise, or an article you've read in Wall Street Journal because you related it to the course you were taking, but would have missed otherwise. I encourage students to learn things outside of class. I will sometimes point you to the facts or readings that I find interesting, and may ask you to write a page or two, or lead a discussion on such a topic. Because these topics often come up after the grading system has been announced and we are well into the semester, I will assign extra-credit points to them. A few things need to be noted:

- You *do not need* extra credit to do well in this class. Please do not feel obligated to turn in extra-credit assignments you are not interested in doing.

- Extra-credit assignments are due on their due date, and cannot be made up for ANY reason (including university-approved absences).
- DO NOT ask me for extra-credit assignments at the end of the semester if you are a few points short of your desired grade. Take care of any potential shortfalls when the opportunities are provided.
- Extra-credit opportunities will be offered to everyone. No individual extra-credit assignments will be offered or provided for any reason.

### Homeworks

In this class, homeworks are essential for learning. Simply put, you CANNOT learn statistics by simply attending the class. Homeworks will be more along the lines of the real-life problems that you will have to solve in the future, and you will have a week after the topic was introduced in class to work on these. Homework assignments are handed out in class (during seminars) and will be available electronically. I strongly recommend that you do not wait until the due date to complete those, and work on the problems a few at a time throughout the assigned period.

Due dates for all homeworks are clearly stated in the syllabus. Late homeworks are not accepted for ANY REASON. All homeworks should be submitted to me via LMS.

### Quizzes

You cannot meaningfully participate in the seminar if you have missed my lecture and did not do any reading. Therefore, to encourage you to prepare for seminars, every seminar will have a quiz on the lecture material and all assigned readings for the week. This includes the very first seminar, which will focus on Lecture 1 material. You are allowed to miss any one quiz (skip a seminar, not prepare, etc.) – in other words, I will count the best 9 out of 10 quizzes that we will have. If you submit all ten, I will count best nine. All quizzes will be done online and submitted to me via SurveyMonkey (links will be given in class).

**Important:** I record IP addresses and only accept quizzes submitted from with the HSE IP address. Quizzes submitted from other locations are NOT counted towards your grade. In other words, to participate in a quiz, you have to be present in class.

### In-class Labs

There will be a lab assignment in almost every seminar, depending on our progress. Since we will be learning SAS, and learning quickly, you will need to devote a substantial time to it. Seminar labs should help you with this task. At the end of the lab, you will submit your completed assignment for the day (or as much as you were able to complete) to me via LMS.

### Rounding and grade calculation

Your final grade is an average of a cumulative grade and a final exam grade. Grades earned as percentages will translate into point grades in 10% increments: 10% - 1 point. 20% - 2 points, etc. Grades will be assigned as whole grades only. Grade rounding follows the standard mathematical averaging rules: 34.9% is a 3; 34.99999% is a 3, and only 35.0% is a 4. I know 1/10 of a percent is not a big deal, but please do not ask me to “bump” your grade 1/10 of a percent; earn it instead.

## **IV. Tips for Success and Other Issues of Concern**

### Absences and Excuses

You are responsible for attending class. If you miss class, you are still responsible for everything covered in class, including announcements. Absences excuse you (the body) **NOT ANY WORK THAT IS DUE, even if excuse is documented.** Failure to turn in assignments on time will result in a loss of participation/responsibility points, and a zero on the assignment. Similarly, being absent does not excuse you from obtaining handouts and assignments that you may have missed. It is your responsibility to find out what you have missed and to make arrangements to obtain any handouts, assignments, etc. All work is due as stated in the course schedule. **Exception: religious observance absences as stated below.**

**Religious Observance:** In keeping with university policy, accommodations will be made for observance of religious holidays. I require that you request accommodations in advance by notifying me in writing.

### Class preparation

Considering that class preparation is a personal matter, and that there is no one formula, the following are some generally recommended guidelines for most cases:

1. Read the assigned material quickly, noting the major issues and a general sense of the layout. Read to get a sense of what the chapter is about. Ask yourself how you can relate to the materials covered, and whether all the new terms make sense.
2. Reread the material carefully, annotating, highlighting and distinguishing important information, omissions, and questions raised by the reading.
3. Decide what the most important issues are. Write down questions you don't understand.
4. Discuss the chapter with others, before class if possible, to test out your ideas and further your understanding of the issues.
5. Prepare notes to guide your class participation, including: answering assigned questions, summary of the main issue(s), further questions raised by the reading, assumptions made by the chapter, your personal experiences, and possible approaches or solutions to any problems assigned with the chapter.
6. **DO YOUR HOMEWORK and ATTEND SEMINARS TO COMPLETE LABS.**

### Virtual Office Hours – LMS Forum

This is a very large class, and I may not be able to answer all questions that are e-mailed to me on a timely basis. Moreover, I've found over the years that usually 90% of all questions from students are nearly identical – that is, if you do not understand something, chances are, most other people do not, either. Instead of repeating answers over and over via email, I will be answering all content-related questions in LMS forum (it is already open for the class, please feel free to start threads and ask questions).

**Feel free to answer questions posted on the Forum.** Not only that will provide an answer to your peers quicker (I may not be able to respond to Forum questions immediately), but I will also monitor your Forum activities and will provide **extra-credit** to the most active students who provide best answers.

### Messages and Memos for Me

If you have any messages or specific requests for me, please submit them by e-mail or in typed format. Ensure that your message includes your name, a complete description of your concern, and a recommendation for resolution. Please note that I have a very busy inbox; usually, I answer emails only once a day, very early in the morning. So if you send me a question around 10 am, please do not expect to receive answer until the following day.

### Stay Informed about Class Schedules & Policies

It is the student's responsibility to stay informed about class schedules and policies. The information you need is included on both the paper copy of the syllabus, and the online website pages. In addition,

announcements will be made regularly in class and on website, and it is your responsibility to keep up with that information. If you are unclear about any policies or other information, please ask promptly. Don't wait and get an unpleasant surprise later.

### Participation Ground Rules

In an effort to provide a classroom environment as conducive to learning as possible, the following ground rules should be observed:

1. *Confidentiality.* Concepts and ideas can be taken from the class and discussed freely. However, personal stories or issues raised by individuals are to be kept confidential and as the property of the class.
2. *Respectful Listening.* When differing with another participant's point of view, listen first before raising questions. When another participant raises a point we disagree with or find offensive, it is important to remember that the human being behind that question or comment deserves respect. Please freely utilize the concepts we'll learn in the second week of class.
3. *Participation.* Participants who tend to be quieter are encouraged to contribute to enhancing the learning process by sharing their perspectives and experiences. Those who are aware they are prone to monopolizing discussions are encouraged to self-monitor their behavior and make room for quieter students.
4. *No Zaps.* In keeping with the notion of respectful listening, "putting-down" others in class is discouraged. "Zapping" another person often serves to discourage open and honest exchange of ideas among the whole group.

### Academic Honesty

Scholastic dishonesty, including cheating in exams or plagiarism, will be treated as a violation of university's regulations. As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the most severe forms of academic dishonesty and can be expected to result in appropriate consequences.

You must complete exams and assignments alone, except group exercises. You may use only the materials I specify to help you complete your work. If, due to a disability or extraordinary circumstances, you need special accommodations or help in completing course requirements, you must see the instructor BEFORE the exam or assignment due date.

Personally, I have no tolerance for cheating, regardless of the reason. **Simply put, don't do it.**

### Copyright Notice

All handouts in this course are copyrighted, including all materials posted on the website for this course. "Handouts" refers to all materials generated for this class, which include but are not limited to the syllabus, class notes, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. You have the right to download materials from the course website for your own use during this class; however, because these materials are copyrighted, you do not have the right to copy the handouts for other purposes unless the instructor expressly grants permission.

**Good luck and have fun!**

## **V. Course Content**

The topics to be covered in course, with assigned readings and corresponding assignments, are listed below. They are subject to change with notice, and topics may not always be given in the order listed; please see the class schedule provided in the separate document. Each lecture will be accompanied by a corresponding lab (provided separately).

- Lecture 1 – Introduction to the framework of Regression Analysis  
*Data, samples, variables and graphs.*
- Lecture 2 – Simple Linear Regression I  
*Fitting the Linear curve.*
- Lecture 3 – Simple Linear Regression II  
*Ordinary Least Squares (OLS) and Goodness of Fit measures (Pearson  $r$  and  $R^2$ )*
- Lecture 4 – Statistical Inference in a Simple Linear Regression I  
*Model assumptions and properties of OLS estimates, ANOVA.*
- Lecture 5 – Statistical Inference in a Simple Linear Regression II  
*Hypothesis Testing and Confidence intervals for regression coefficients.*
- Lecture 6 – Statistical Inference in a Simple Linear Regression III  
*Confidence intervals, prediction intervals and Regression through the origin.*
- Lecture 7 – Model Diagnostics in a Simple Linear Regression  
*Residual Analysis (graphs, constant variance, correlation).*
- Lecture 8 – Multivariate Regression I  
*Two independent variables (OLS estimates, Goodness of Fit, Inference).*
- Lecture 9 – Multivariate Regression II  
*General Multivariate case (OLS estimates, Goodness of Fit with  $\text{adj } R^2$ , Inference, ANOVA, Analysis of Residuals).*
- Lecture 10 – Model Building I  
*Variable selection and information measures (Akaike, Schwarz,  $\text{adj } R^2$ ).*
- Lecture 11 – Model Building II  
*Influential observations and Multicollinearity.*
- Lecture 12 – Model Building III  
*Transformations of variables and Dummy variables*