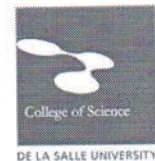




**DE LA SALLE UNIVERSITY**  
**College of Science**  
**Mathematics and Statistics Department**



**LINMODE – Linear Models**  
 Prerequisite: STATHE2, MTRXTHE

Prerequisite to: \_\_\_\_\_

**Instructor:** \_\_\_\_\_  
**Consultation Hours:** \_\_\_\_\_

**Contact details:** \_\_\_\_\_  
**Class Schedule and Room:** \_\_\_\_\_

**Course Description**

A study of the various linear statistical models that arise in practice. Topics include multivariate normal distribution, distribution of quadratic forms, general linear models, estimation and tests of hypotheses about linear hypotheses and design matrices giving rise to analysis of variance models.

**Learning Outcomes**

On completion of this course, the student is expected to present the following learning outcomes in line with the Expected Lasallian Graduate Attributes (ELGA) and the outcomes prescribed by the CHED Memorandum Order for the BS Statistics program.

ELGA	Learning Outcome	Program Outcome													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Critical and Creative Thinker Effective Communicator Lifelong Learner	At the end of the course, the student will														
	understand the concepts, limitations, interpretations, and uses of a regression model	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
	analyze linear models: intuition, implementation and interpretation	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
	interpret regression results in solving real-life problems	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓

**Program Outcomes (BS Statistics)**

- A graduate of the program should be able to
1. Demonstrate broad and coherent knowledge and understanding of the core areas of statistical theory and statistical modeling.
  2. Apply critical and problem solving skills using the scientific method.
  3. Interpret scientific data and make judgments that include reflection on relevant scientific and ethical issues.
  4. Carry out basic mathematical and statistical computations and use appropriate technologies in (a) the analysis of data; and (b) In pattern recognition, generalization, abstraction, critical analysis and problem solving.
  5. Communicate information, ideas problems and solutions, both, orally and in writing, to other scientists, decision makers and the public.
  6. Relate science and mathematics with other disciplines.
  7. Design and perform safe and responsible techniques and procedures in laboratory or field practices.
  8. Critically evaluate input from others.
  9. Appreciate the limitations and implications of science in everyday life.
  10. Commit to the integrity of data.
  11. Demonstrate broad and coherent knowledge and understanding in the core areas of statistics, computing and mathematics.
  12. Generate information involving the conceptualization of a strategy for generating timely and accurate/reliable data, organizing a process for putting together or compiling the needed data, and transforming available data into relevant and useful forms.
  13. Translate real-life problems into statistical problems.
  14. Identify appropriate statistical tests and methods and their proper use for the given problems, select optimal solutions to problems and make decision in the face of uncertainty.



### Final Course Output

As evidence of attaining the above learning outcomes, the student is required to submit the following during the indicated dates of the term.

Learning Outcome	Required Output	Due Date
At the end of the course, the student will perform regression analysis, apply appropriate statistical concepts, processes, tools, and technologies in solving various conceptual and real-world problems.	An inquiry-based group project highlighting the use of regression analysis in different problem situations encountered in the real world.	Week 13

### Rubric for assessment

CRITERIA	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
<b>Formulation of the Research Problem and Objectives (10%)</b>	Research problem and objectives are clearly defined and significant; demonstrates evidence that the research problem was researched and designed well.	Research problem and objectives are clearly defined and significant.	Research problem is clearly defined but some objectives are insignificant.	Research problem and objectives are vague and insignificant.
<b>Correct Application of the Statistical Concepts (35%)</b>	Statistical analyses are appropriate with correct interpretations and relevant conclusions.	Statistical analyses are appropriate with correct interpretations.	Some statistical analyses are inappropriate.	Statistical analyses are inappropriate.
<b>Depth of Analysis (30%)</b>	The analysis convinces the reader about the wisdom of conclusions, implications and consequences on the basis of statistical methods and findings.	The analysis engages the reader to appreciate the wisdom of conclusions, implications and consequences on the basis of statistical methods and findings.	The analysis has limited ideas that do not explain the wisdom of conclusions, implications and consequences on the basis of statistical methods and findings.	The analysis has incorrect ideas and conclusions.
<b>Clarity and Organization of Written Report (10%)</b>	Written report is organized logically and presented clearly with effective transitions.	Written report is organized logically and presented clearly.	Written report is organized and some discussions are not clear.	Written report is not organized.
<b>Oral Presentation (15%)</b>	Overall presentation is creative and well organized with innovative ideas.	Overall presentation is creative and well organized.	Overall presentation is organized.	Overall presentation is not organized.

### Additional Requirements

- Quizzes
- Class Participation (seatwork and group exercises, homework, recitation)
- Computer laboratory activities using SAS and/or Statistica
- Final Examination



### Grading System

	FOR EXEMPTED STUDENTS (w/out Final Exam)	FOR STUDENTS with FINAL EXAM	
		with no missed quiz	With one missed quiz
Average of quizzes & Project	86%	60%	50%
Class participation & Lab exercises	14%	10%	10%
Final exam	-	30%	40%

#### Scale:

95-100%	4.0
89-94%	3.5
83-88%	3.0
78-82%	2.5
72-77%	2.0
66-71%	1.5
60-65%	1.0
<60%	0.0

### Learning Plan

LEARNING OUTCOME	TOPIC	WEEK NO.	LEARNING ACTIVITIES
At the end of the course, the student will perform regression analysis, and apply appropriate statistical concepts, processes, tools, and technologies in solving various conceptual and real-world problems.	1. Simple Linear Regression 1.1 The Problem and Motivation Behind Curve Fitting 1.2 The Least Squares Estimates 1.3 Maximum Likelihood Estimates 1.4 Inference Regarding $\beta_0, \beta_1, \sigma^2, \beta_0 + \beta_1 X_0$ 1.5 Correlation: Inference and Relationship to Simple Linear Regression Model	Weeks 1-4	Prior knowledge and beliefs survey Concept mapping Library work Group discussion and presentations Computer laboratory activities (SAS and/or Statistica)* Skills exercises* Student self-assessment and reflection
	<b>Quiz No. 1</b>	<b>Week 5</b>	
	2. Measures of Model Adequacy 2.1 Tests for Linearity 2.2 Tests for Normality 2.3 Tests for Homoscedasticity 2.4 Tests for Independence 2.5 Outliers Detection 2.6 Transformations	Weeks 5-6	
	3. Multiple Linear Regression 3.1 Matrix Representation and Estimation of Parameters 3.2 Algebraic/Geometric Interpretation of Multiple Linear Regression Model 3.3 Tests and Confidence Intervals Based on the t Distribution 3.4 Full versus Reduced Model: The Partial F Test 3.5 Extra Sum of Squares and Multicollinearity	Weeks 7-10	
	<b>Quiz No. 2</b>	<b>Week 10</b>	

	4. Variable Selection and Model Building 4.1 Criteria for Selecting Appropriate Models: MSE, $C_p$ , and adjusted $R^2$ 4.2 Forward Selection, Backward Elimination and Stepwise Selection Procedures 4.3 Multicollinearity: The PRESS Statistic and the Hat Matrix	Weeks 11-12	
	<b>Quiz No. 3</b>	<b>Week 12</b>	
	5. Issues in Regression Modeling	Week 13	
	Inquiry-based Group Project	Week 13	
	<b>Final Examination</b>	<b>2 hours / Week 14</b>	

\*Skills exercises/ computer laboratory activities are given weekly and the students are expected to work on the solutions for their fourth hour activity. At the end of the term, the solutions to the problems will be compiled and submitted as one of the course outputs.

### References

- Agresti, A. (2015). *Foundations of Linear and generalized linear models*. New Jersey: Wiley
- Bapat, R. B. (2012) *Linear algebra and linear models*. New Delhi: Hindustan Book Agency/Springer.
- Christensen, R. (2011). *Plane answers to complex questions [electronic resource]: The theory of linear models*. New York, NY: Springer New York.
- Draper, N.P., & Smith, H. (1998). *Applied regression analysis (3<sup>rd</sup> ed.)*. New York: Wiley.
- Freedman, D. (2009). *Statistical models: theory and practice*. Cambridge: Cambridge University Press.
- Gruber, M. (2014) *Matrix Algebra for Linear Models*. New Jersey: Wiley
- Hayes, A. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-based Approach*. New York: The Guilford Press.
- Kahane, L. H. (2008). *Regression basics*. Los Angeles: Sage Publications.
- Kleinbaum, D. (2013). *Applied Regression Analysis and Other Multivariate Methods*. Stamford, CT: Cengage
- Montgomery, D.C. & Peck, E.A. (1992). *Introduction to linear regression analysis (2<sup>nd</sup> ed.)*. New York: Wiley.
- Neter, J., Kutner, M., Wasserman, W., & Nachtsheim, C. (1996). *Applied linear regression models (3<sup>rd</sup> ed.)*. Chicago: Irwin.
- Neter, J., Kutner, M., Wasserman, W., & Nachtsheim, C. (1996). *Applied linear statistical models (4<sup>th</sup> ed.)*. Chicago: Irwin.
- Weisberg, S. (2014) *Applied Linear Regression*. New York: Wiley.
- Yan, X. (2009). *Linear regression analysis: theory and computing*. Hackensack, NJ: World Scientific.

### Online Resources

- Chen, X., Ender, P., Mitchell, M. and Wells, C. (2003). *Regression with SAS*, from <http://www.ats.ucla.edu/stat/sas/webbooks/reg/default.htm>. Accessed September 14, 2012
- StatSoft, Inc. (2012). *Electronic Statistics Textbook*. Tulsa, OK: StatSoft. WEB: <http://www.statsoft.com/textbook/>. Accessed September 14, 2012
- Lock, R. (1998) *WWW Resources in teaching Statistics* from <http://it.stlawu.edu/~rlock/tise98/onepage.html>. Accessed September 14, 2012.
- West, R. *Regression Applet* from <http://www.stat.sc.edu/~west/javahtml/Regression.html>. Accessed September 14, 2012.



### Class Policies

1. The required minimum number of quizzes for a 3-unit course is 3, and 4 for 4-unit course. No part of the final exam may be considered as one quiz.
2. Cancellation of the lowest quiz is not allowed even if the number of quizzes exceeds the required minimum number of quizzes.
3. As a general policy, no special or make-up tests for missed exams other than the final examination will be given. However, a faculty member may give special exams for
  - a. approved absences (where the student concerned officially represented the University at some function or activity).
  - b. absences due to serious illness which require hospitalization, death in the family and other reasons which the faculty member deems meritorious.
4. If a student missed two (2) examinations, then he/she will be required to take a make up for the second missed examination.
5. If the student has no valid reason for missing an exam (for example, the student was not prepared to take the exam) then the student receives 0% for the missed quiz.
6. Students who get at least 89% in every quiz are exempted from taking the final examination. Their final grade will be based on the average of their quizzes and other prefinal course requirements. The final grade of exempted students who opt to take the final examination will be based on the prescribed computation of final grades inclusive of a final examination. Students who missed and/or took any special/make-up quiz will not be eligible for exemption.
7. Learning outputs are required and not optional to pass the course.
8. Mobile phones and other forms of communication devices should be on silent mode or turned off during class.
9. Students are expected to be attentive and exhibit the behavior of a mature and responsible individual during class. They are also expected to come to class on time and prepared.
10. Sleeping, bringing in food and drinks, and wearing a cap and sunglasses in class are not allowed.
11. Students who wish to go to the washroom must politely ask permission and, if given such, they should be back in class within 5 minutes. Only one student at a time may be allowed to leave the classroom for this purpose.
12. Students who are absent from the class for more than 5 meetings will get a final grade of 0.0 in the course.
13. Only students who are officially enrolled in the course are allowed to attend the class meetings.

Approved by:



**DR. JOSE TRISTAN F. REYES**  
Chair, Mathematics and Statistics