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

**APMULTI**– Applied *Multivariate Analysis*
*Prerequisite:LIMOBAP* *Prerequisite to:*

**Instructor:**_____ **Contact details:**_____
**Consultation Hours:**_____ **Class Schedule and Room:**_____

## Course Description

A course dealing with discriminant analysis, analysis of covariance, multivariate analysis of variance, canonical correlation, factor analysis and cluster analysis.

## 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 Mathematics program.

| ELGA | Learning Outcome | Program Outcome | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | At the end of the course, the student will | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Critical and Creative Thinker<br>Effective Communicator<br>Lifelong Learner | apply appropriate multivariate techniques, statistical concepts, processes, tools, and technologies in solving various conceptual and real-world problems. | ✓ | ✓ | | ✓ | ✓ | | | ✓ |

## Program Outcomes (BS Mathematics)

A graduate of the program should be able to

1. Apply analytical, critical and problem solving skills using the scientific method.
2. Carry out basic mathematical and/or statistical computations and use appropriate technologies in the analysis of data, and in pattern recognition, generalization, abstraction, critical analysis, and problem solving.
3. Gain mastery in the core areas of mathematics: algebra, analysis and geometry
4. Demonstrate skills in pattern recognition, generalization, abstraction, critical analysis, problem-solving and rigorous argument.
5. Develop an enhanced perception of the vitality and importance of mathematics in the modern world, including the interrelationships within mathematics and its connection to other disciplines
6. Appreciate the concept and role of proof and reasoning and demonstrate knowledge in reading and writing mathematical proofs.
7. Make and evaluate mathematical conjectures and arguments and validate their own mathematical thinking
8. Communicate mathematical ideas orally and in writing using clear and precise language

## 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 apply appropriate multivariate techniques, statistical concepts, processes, tools, and technologies in solving various conceptual and real-world problems. | An inquiry-based group project highlighting the use of multivariate technique(s) in different problem situations encountered in the real world. | Week 13 |

## Rubric for assessment

**A. Problem Set**

| CRITERIA | Excellent (4) | Good (3) | Satisfactory (2) | Needs Improvement (1) |
|---|---|---|---|---|
| ***Formulation of the Research Problem and Objectives (10%)*** | 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. | The solution shows a deep understanding of the problem including the ability to identify the appropriate mathematical concepts and information |

| | | | | |
|---|---|---|---|---|
| | | | | necessary for its solution. |
| ***Correct Application of the Statistical Concepts (35%)*** | Statistical analyses are appropriate with correct interpretations and relevant conclusions. | Statistical analyses are appropriate with correct interpretations. | Some statistical analyses are inappropriate. | Uses a very efficient strategy leading directly to a solution. Applies procedures accurately to correctly solve the problem and verifies the result. |
| ***Depth of Analysis (30%)*** | 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. | There is a clear, effective explanation, detailing how the problem is solved. There is a precise and appropriate use of mathematical terminology and notation. |
| ***Clarity and Organization of Written Report (10%)*** | 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. |
| ***Oral Presentation (15%)*** | 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 laboratoryactivitiesusing SAS and/or STATISTICA
- Final Examination

## Grading System

| | **FOR EXEMPTED STUDENTS (w/out Final Exam)** | **FOR STUDENTS with FINAL EXAM** | |
|---|---|---|---|
| | | *with no missed quizzes* | *with one missed quiz* |
| Average of quizzes& project | 86% | 60% | 50% |
| Class Participation and 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 apply appropriate multivariate techniques, statistical concepts, processes, tools, and technologies in solving various conceptual and real-world problems. | **I. Preliminaries**<br>1.1 Some Basic Concepts of Multivariate Analysis<br>1.2 Some Basic Concepts of Multivariate Analysis<br>1.3 Types of Multivariate Techniques<br>1.4 Classification of Multivariate Techniques<br>1.5 Assumption Checking | 3 hours / Week 1 | Prior knowledge and beliefs survey<br>Concept mapping<br>Library work<br>Group discussion and presentations<br>Computer laboratory activities (SASand/or Statistica)*<br>Skills exercises*<br>Student self-assessment and reflection |
| | **II. Multivariate Analysis of Variance (MANOVA)**<br>2.1 Description of MANOVA<br>2.2 Objectives of MANOVA<br>2.3 Assumptions of MANOVA<br>2.4 One-Way and Two-Way MANOVA<br>2.5 Applications of MANOVA<br>2.6 Post-hoc Analysis | 7.5 hours / Weeks 2-4 | |
| | **Quiz No. 1** | **1.5 hours / Week 4** | |
| | **III. Discriminant Analysis**<br>3.1 Description of Discriminant Analysis<br>3.2 Objectives of Discriminant Analysis<br>3.3 Assumptions of Discriminant Analysis<br>3.4 Linear and Quadratic Discriminant Functions<br>3.5 Classification Tables<br>3.6 Applications of Discriminant Analysis | 6 hours / Weeks 5-6 | |
| | **IV. Factor Analysis**<br>4.1 Description of Factor Analysis<br>4.2 Objectives of Factor Analysis<br>4.3 Assumptions of Factor Analysis<br>4.4 Naming of Factors<br>4.5 Orthogonal and Oblique Rotations<br>4.6 How to Select Surrogate Variables for Subsequent Analysis<br>4.7 How to Use Factor Scores<br>4.8 Applications of Factor Analysis | 6 hours / Weeks 7-8 | |
| | **Quiz No. 2** | **1.5 hours / Week 9** | |

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|---|---|---|---|
| | **V. Cluster Analysis**<br>5.1 Description of Cluster Analysis<br>5.2 Assumptions of Cluster Analysis<br>5.3 Similarity/Dissimilarity Measures<br>5.4 Types of Clustering Techniques<br>5.5 Applications of Cluster Analysis | 4.5 hours / Weeks 9-10 | |
| | **VI. Canonical Correlation Analysis**<br>6.1 Description of Canonical Correlation Analysis<br>6.2 Objectives of Canonical Correlation Analysis<br>6.3 Assumptions of Canonical Correlation Analysis<br>6.4 Canonical Variates<br>6.5 Applications of Canonical Correlation Analysis | 4.5 hrs / Weeks 11-12 | |
| | **Quiz No. 3** | **1.5 hours / Week 12** | |
| | Inquiry-based Group Project | 3 hours / Week 13 | |
| | **Final Examination** | **2 hours / Week 14** | |

*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


Abbott, M. (2017). Using Statistics in the Social and Health Sciences with SPSS and Excel. NJ: Wiley

Aggarwal, C. & Reddy, C. (2014). Data Clustering: Algorithms and Applications. Boca Raton: CRC Press

Delwiche, L.D, & Slaughter, S.J. (2003). *The little SAS book: a primer* (3rd ed.). Cary, NC: SAS Pub.

Everitt, B. &Hothorn, T. (2011). *An introduction to applied multivariate analysis with R [electronic resource].* New York, NY; Springer New York.

Fichet, B. (2011). *Classification and multivariate analysis for complex data structures [electronic resource].* Berlin, Heidelberg: Springer BerlinHeiderberg.

Hair, J.F., Black, B., Babin, B., Anderson, R.E., & Tatham, R.L. (2010). *Multivariate data analysis: a global perspective* (7th ed.). Upper Saddle River, NJ: Pearson.

Johnson, R.A., & Wichern, D.W. (2007). *Applied multivariate statistical analysis* (6th ed.). Upper Saddle River, NJ: Pearson Education International.

King, R. (2015). Cluster Analysis and Data Mining: An Introduction. Virginia: Mercury Learning and Information

Kleinbaum, D. (2013). Applied Regression Analysis and Other Multivariate Methods. Stamford, CT: Cengage

Lattin, J.M., Carroll, J.D., & Green, P.E. (2003). *Analyzing multivariate data*. Pacific Grove, CA: Thomson Brooks/Cole.

Loehlin, J. (2017). Latent Variable Models: An Introduction to Factor, Path, and Structural Equation Analysis. NY: Routledge

Marascuilo, L.A., & Levin, J.R. (1983). *Multivariate statistics in the social sciences: a researcher's guide*. Monterey, California: Brooks/Cole Pub. Co.

Morrison, D.F. (1990). *Multivariate statistical methods (3rd ed.).*Singapore: McGraw-Hill.

Mukhopadhyay, P. (2009). *Nultivariate statistical analysis.* Hackensack, NJ: World Scientific.

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences.* New York: Routledge.

Timm, N.H. (2002). *Applied multivariate analysis.* New York: Springer.


## Online Resources

Lock (1998) *WWW Resources for Teaching Statistics.* Accessed October 25, 2012 from: http://it.stlawu.edu/~rlock/tise98/onepage.html

*Big Data, Data Mining, Predictive Analytics, Statistics, StatSoft Electronic Textbook.* Accessed October 25, 2012 from: http://www.statsoft.com/textbook/

## 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