Department of …Statistics & Informatics….

College of Administration and Economics

University of Salahaddin-Erbil

Subject: Multivariate Statistical Analysis

Course Book: Diploma Students

Lecturer's name: Dr. Delshad Shaker Botani (PhD)

Academic Year: 2023 – 2024

Course Book

1. Course name	Multivariate Statistical Analysis
2. Lecturer in charge	Dr. Delshad Shaker Ismael Botani
3. Department/ College	Statistics & Informatics /Adm. & Eco.
4. Contact	e-mail: **delshd.botani@su.edu.krd** Tel: (0750)
5. Time (in hours) per week	Theory: 3 Practical: 0
6. Office hours	Wednesday from 9:00 AM to 12:00 PM
7. Course code	
8. Teacher's academic profile	From 1996 until 2000, I worked as an assistant lecturer in Statistics department – Salahaddin University. In 2002, I had MSc. in Statistics from the same university. Then, from 2004 until the end of 2005 I worked in the Mathematics department – Science College teaching some statistical subjects such as Statistics, Probability, Math. Statistics, SPSS, with supervision of students' graduation projects. At the same time, I was the head of Computer unit at Science College. After that I accepted in the PhD scholarship in Russia and commenced the study in Moscow State University for Economics, Statistics, and Informatics (MESI) at the end of 2005. In 2010, I had my PhD in Statistics from the MESI university. Since 2010 I am working as a lecturer in Statistics department – Salahaddin University teaching statistical subjects and supervising BSc. and MSc. students. Also, I was a lecturer in the College of Police in Erbil city teaching computer science subject. I am the owner of one published book written in Kurdish language named "Amarzani" which means Statistics. I have more than 12 scientific researches in Statistics field. From 2017, my scientific level changes to assistant Professor. During my presence in this field, I have taught the following subject: Statistics, Visual Basic, SPSS, Probability, Math. Statistics, Operations Researches, Research Methodology, Surveys, Multivariate Statistics. I am a member in the following organizations: ✓ Head of STATISTICS Organization for Society Support (SOSS) in KRG (From 2021 – Till now). ✓ ESOMAR (ESOMAR is the essential organization for encouraging, advancing and elevating market research worldwide (From 2012 – Till now); https://www.esomar.org/community/our-community/member-search/profile681531_Delshad-Botani.php ✓ KURDISTAN ECONOMIST SYNDICATE in KRG (From 2010 – Till now): Conducting feasibility studies of many sectors, such as: industry, real estate, agriculture, Banking, Health care, Education, Oil and gas producers, etc. More than 100 feasibility studies conducted from 2011 till now.
9. Keywords	Multivariate Normal Distribution, Multiple Correlation Coefficient, Hotelling T^2, MANOVA.

10. Course overview:

Most of the observable phenomena in the empirical sciences are of a multivariate nature. In the past 20 years, with the computer application technology and the urgent need for research and production, multivariate statistical analysis techniques are widely used in geology, meteorology, hydrology, medicine, industry, agriculture and economic and many other fields, has become to solve practical problems in effective way.

The course covers a wide range of topics, starting with the foundations of multivariate normal distribution and the principles of multivariate statistical modeling. Through a series of lectures, discussions, and hands-on exercises, students will explore various multivariate techniques, including partial, multiple, and canonical correlations, hypothesis testing in multivariate contexts, and the application of Multivariate Analysis of Variance (MANOVA). As the course progresses, students will gain proficiency in multivariate regression essential for solving complex research questions.

Throughout the course, students will develop critical thinking skills, research competence, and proficiency in relevant statistical software. The culmination of their learning journey will be a capstone project that allows them to apply the acquired knowledge to a practical research problem, demonstrating their expertise in Multivariate Statistical Analysis. The practical components of the course will be facilitated using the renowned SPSS software, a widely recognized statistical tool using SPSS syntax.

By the end of this course, students will be well-prepared to tackle complex research challenges and contribute to the advancement of statistical knowledge in their respective fields.

11. Course objective:

The following are the most important objectives of this course:

This advanced course in Multivariate Statistical Analysis equips Diploma students with a comprehensive understanding of complex data analysis. Students will delve into fundamental concepts, including multivariate normal distribution and correlation techniques. They will master hypothesis testing in multivariate scenarios, apply T tests and Multivariate Analysis of Variance (MANOVA), and explore multivariate regression analysis. This course fosters critical thinking, research proficiency, and software competence, culminating in a capstone project that demonstrates their multivariate expertise. Learning how to interpret the results of a computer analysis of a multivariate data set using SPSS Package (v.27).

12. Student's obligation

Students are expected to:

- Follow university policies when attending class and lab, and taking sudden quizzes and exams.
- Student should be proud of the work that he/she do in this class. Do not allow someone else to copy your homework and do not provide answers to quizzes or tests. If this does occur, credit will be lost and a referral will be written.

13. Forms of teaching

The focus will be on some forms of teaching such as classical teaching with PowerPoint presentations for the head titles, whiteboard, definitions and summary of conclusions, classification of materials and any other illustrations, solving the examples by sharing the students to get them will understand, and students should participate as much as possible in lecture's discussions and presenting seminars on subjects determined by the lecturer.

14. Assessment scheme

The students are obliged to perform at least one closed book exam (Midterm Exam) during the academic semester. The exam has approximately 20%, besides homework, quizzes, classroom activities, and presentation as seminar about – 30%. The other 50% will be reserved for the final exam. Therefore, the final grade will be based upon the following criteria:

Midterm Exam : 20%
HW, quizzes, seminars, interactive activities: 30%
Final Exam : 50%

15. Student learning outcome:

After the completion of this course in this academic semester, the students will be able to do the following:

- Appreciate the range of multivariate techniques available;
- Summarize and interpret multivariate data;
- Understanding of the link between multivariate techniques and corresponding univariate techniques;
- Using multivariate techniques appropriately, undertake multivariate hypothesis tests, and draw appropriate conclusions.

16. Course Reading List and References:

1) Daniel J. Denis (2019). *SPSS data analysis for univariate, bivariate, and multivariate statistics*. NJ: Wiley, 2019
2) Keenan A. Pituch & James P. Stevens (2016). *Applied Multivariate Statistics for the Social Sciences: Analyses with SAS and IBM's SPSS (6th ed.).* Routledge
3) ALVIN C. RENCHER, William F. Christensen (2012). *Methods of Multivariate Analysis* (3rd ed.). John Wiley & Sons.
4) Johnson, Richard A.; Wichern, Dean W. (2014). *Applied Multivariate Statistical Analysis (Sixth ed.).* Prentice Hall.
5) Anderson, T. W. (2003). *An Introduction to Multivariate Statistical Analysis (3rd ed).* Wiley, New York.
6) Siotani, M., Hayakawa, T., and Fujikoshi, Y. (1985). *Modern Multivariate Statistical Analysis.* Columbus, Ohio: American Sciences.
7) Eaton, M. L. (1983). *Multivariate Statistics.* Wiley, New York.
8) Mardia, K.V., Kent, J.T. and Bibby, J.M. (1979). *Multivariate Analysis*. Academic Press, London.
9) Bock, R. D. (1975). *Multivariate Statistical Methods in Behavioural Research.* New York: McGraw-Hill.

17. The Topics:	**Lecturer's name**
1) Introduction and overview of the course. Some principles of multivariate statistical modelling. 2) Linear Algebra and Matrices 3) Multivariate Normal distribution 4) Partial, Multiple, and Canonical Correlations. 5) Multivariate One-Sample, Two-Sample, or Subvector Testing 6) Multivariate Analysis of Variance (MANOVA) 7) Multivariate Regression	Dr. Delshad Botani Two hours a week

18. Practical Topics (If there is any)

Anything related topics to the MSA using SPSS are considered as Practical Topics.

19. Examinations:

I. **Proofs and solutions:** Any proofs or solutions for practical questions may be provided in the exam and students should solve those questions or proof those theorems that are given at daily lectures (It is possible to solve this type of questions in any way), such as the following questions:

If $B = \begin{bmatrix} 4/5 & -2/5 \\ -2/5 & 1/5 \end{bmatrix}$, Show that B is idempotent matrix.

Solution:

$$B.B = B$$

$$B.B = \begin{bmatrix} 4/5 & -2/5 \\ -2/5 & 1/5 \end{bmatrix} . \begin{bmatrix} 4/5 & -2/5 \\ -2/5 & 1/5 \end{bmatrix}$$

$$B.B = \begin{bmatrix} \frac{16}{25} + \frac{4}{25} & -\frac{8}{25} - \frac{2}{25} \\ -\frac{8}{25} - \frac{2}{25} & \frac{4}{25} + \frac{1}{25} \end{bmatrix}$$

$$B.B = \begin{bmatrix} 20/25 & -10/25 \\ -10/25 & 5/25 \end{bmatrix}$$

$$B.B = B = \begin{bmatrix} 4/5 & -2/5 \\ -2/5 & 1/5 \end{bmatrix}$$

II. **Home Examinations:** This type of exams will be conducted at home through sending an email to the students and they must answer the questions in a determined period or time, then all students must send their answers through the same email, such as the following questions:

Theorem: For every vector $\underline{\alpha}$ if $\underline{X}^{(1)}$ and $\underline{X}^{(2)}$are independent. Let X_i be any Component of $\underline{X}^{(1)}$, Show That for all linear Combination $\underline{\alpha}\,\underline{X}^{(2)}$ Which is Minimize the Variance $\left(X_i - \underline{\alpha X}^{(2)}\right)$.

1. **Proof:** $V\left(X_i - \underline{\alpha X}^{(2)}\right) = V(X_i) + V\left(\underline{\alpha X}^{(2)}\right) - 2Cov\left(X_i, \underline{\alpha X}^{(2)}\right)$

$= V(X_i) + \underline{\alpha}' V\left(\underline{X}^{(2)}\right)\underline{\alpha} - 2\underline{\alpha} Cov\left(X_i, \underline{X}^{(2)}\right)$

$\sum_i = \begin{bmatrix} \sigma_{ii} & \sigma_i \\ \sigma_i' & \sum_{22} \end{bmatrix}$

$= \sigma_{ii} + \underline{\alpha}' \sum_{22} \underline{\alpha} - 2\underline{\alpha}\sigma_i$

$\frac{\partial\left(V(X_i - \underline{\alpha X}^{(2)})\right)}{\partial \underline{\alpha}} = 0 + 2\underline{\alpha}\sum_{22} - 2\sigma_i = 0$

$\underline{\alpha}\sum_{22} - \sigma_i = 0 \qquad) * \sum_{22}{}^{-1}$

$\underline{\alpha}\sum_{22}\sum_{22}{}^{-1} - \sigma_i \sum_{22}{}^{-1} = 0$

$\underline{\alpha} = \sigma_i \sum_{22}{}^{-1}$

$\underline{\beta} = \underline{\alpha} = \sigma_i \sum_{22}{}^{-1}$ Prove

20. Extra notes:

If any student cannot make it to an in-class exam due to a documentable reason, please let me know as soon as possible. Makeup will not be allowed for home works. However, I will double count students future graded assignments in the cases of excused absences.

If you have any suggestions or concerns, either positive or negative, about this class, please do not hesitate to see me during my office hours or make an appointment. It is my hope that I will be able to resolve the issue.

21. Peer review

Dr. Saman Husein Mahmoud
Dr. Rizgar Magdid Ahmed