College of Agricultural Engineering Science/ Salahaddin University- Erbil

Department of Forestry

Experimental design and analysis

Course Book – (Grade 3)

Assist Prof. Dr. Sirwa Anwar Qadir, Ph. D Lecturer
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Academic Year: 2024- 2025
Spring semester

1. Course name	**Experimental design and analysis**
2. Lecturer in charge	**Dr. Sirwa Anwar Qadir** **Miss. Shaymaa Hani Mahmood, Assistant Lecturer**
3. Department/ College	**Forestry department/ Agriculture college**
4. Contact	**e-mail:** **sirwa.qadir@su.edu.krd** **Tel: 009647504701276**
5. Time (in hours) per week	**Theory: 2 hrs, practice: 3 hrs**
6. Office hours	**Availability of the lecturer to the student during the week**
7. Course code	
8. Teacher's academic profile	**BSc (Bachelor of Science) from Biology department/ College of Science, at Salahaddin University, Erbil, Iraq in July 1999. At 2000 to 2003 Lab assistant at Plant Protection Dept. After obtaining MSc (Master of Science) at the college of Education/ Biology department in July 2006 in Plant Physiology, I cooperated as a lecture in Agriculture college, Salahaddin University for a period of 7 years. I have been received Ph. D in plant physiology in an inter-ship program at both Salahaddin University and Universiti Teknologi Malaysia (UTM) July 2017. I have published 14 journal articles, 1 book chapter, research projects.** **Dr. Sirwa A. Qadir**
9. Keywords	Statistics, variable, CRD, RCBD, LSD, DMRT, factorial experiments

10. Course overview:

This course deals with the concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models and appropriate graphical methods.

11. Course objective:

At the end of this course, students should:

1. Have a general understanding of basic statistics and how it applies to research.
2. Have a basic understanding of experimental design; how to plan, conduct, analyze and interpret results of basic experiments.
3. Be able to interpret results of experiments as presented in scientific journals, technical reports and similar publications.
4. Be able to input and manage data in a spreadsheet such as Excel.
5. Be familiar with SPSS and be able to use SPSS in data analysis.

12. Student's obligation

Students must complete Learning assessments based on lecture material and supplementary lecture-related material.

13. Forms of teaching

The lecturer will uses data show by preparing PowerPoint presentations in which outlines of each lecture will be shown however the details of the lecture will be narrated by the lecturer herself. In some cases, samples will be shown to students to have a close and real idea on the subject.

Each student is expected to do all of his/her own work. I encourage you to use the discussion board to assist one another in completing your homework assignments. (You may also ask me for help with assignments.) However, I expect you to turn in your own work as the end product. For the midterm and final exam, I expect you to do all of your own work. You may use other reference materials at your disposal, such as the text book, other books, or the internet, to help you complete the exam.

14. Assessment scheme

Class attendance will be determined through your quizzes and assignments and tests in practical part in 5. The practical part is given 15 marks in total. Students are evaluated during the semester for the

theory part by daily short quizzes which giving 5 marks out of 25. Two term exams 20 mark each out of 25.

15. Student learning outcome:

Having successfully completed this module you will be able to:

- Encounter the principles of randomisation, replication and understand how they apply to practical examples.
- Explore the general theory of factorial and block designs and understand this theory sufficiently to find appropriate designs for specific applications
- Evaluate designs using common optimality criteria and used them to critically compare competing designs
- Applied theory and methods to a variety of applications.
- Used the SPSS statistical software to analyse common forms of experiments.

16. Course Reading List and References:

- Clewer, A.G. and D.H. Scarisbrick. 2001. Practical Statistics and Experimental Design for Plant and Crop Science. John Wiley and Sons, LTD. New York
- Morris, T.R. 1999. Experimental Design and Analysis in Animal Sciences. CABI Publishing, New York.
- Bailey, R. (2008). Design of comparative experiments. Cambridge Series in Statistical and Probablistic Mathematics. Cambridge University Press.
- Dagnelie., P. (1985). Estatística – teoria e métodos. 1º e 2º volume. Publicações Europa-América. Mem Martins.
- Gomez, K. A. e Gomez, A. A. (1984). Statistical procedures for agricultural research. 2nd edition. An International Rice Research Institute Book. John Wiley & Sons. New York.
- Mead, R., Gilmour, S. e Mead, A. (2012). Statistical principles for the design of experiments: applications to real experiments. Cambridge Series in Statistical and Probabilistic Mathematics. Cambridge University Press.
- Montgomery, D. (2012). Design and analysis of experiments. Eighth edition. John Wiley & Sons. New York.

Topics	Lecturer's name
Design of experiments: • Brief history of design of experiments: • Basic terminology in Experiment Design. • Testing Hypothesis: • Principles of experimental design • Independent and Dependent variables	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
Analysis of Variance (ANOVA) • Purpose and use of ANOVA • Ways of Analysis • Model of Design • Preparation of ANOVA table	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
Complete Randomize Design (CRD) • Definition of CRD • Layout of Design • Steps of Design Laying out • Principles of the design • Use of CRD	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
Randomized Complete Block Design (RCBD) • Application • Advantage and disadvantage • Layout of design • Analysis of design	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**

• Principles of design	
Multiple comparison tests **Least Significant Difference (LSD)** • Calculation of LSD • Use and application of LSD **Dunett's test** • Calculation of Dunett's test • Use and application of Dunett's test	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
DRMRT Duncan's Multiple Range test • Calculation of DRMRT • Use and application of DRMRT	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
Mid- term exam	
Factorial Experiment • Definition • Advantages and Disadvantages of Factorial Experiment • Combinations Calculations Analysis of Factorial Experiment	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
CRD design in Factorial Experiment • Lay out • Advantages and Disadvantages of Factorial Experiment	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha** (3 hrs)
RCBD design in Factorial Experiment • Lay out • Advantages and Disadvantages of Factorial Experiment	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**
Split Plot Design • Uses • Advantages and Disadvantages of Split Plot Design • Layout of the design • Calculations • Differences between Split Plot Design and Factorial Experiment • Similarities	**Dr. Sirwa A. Qadir (2 hrs)** **Narin Siammand Ali and Zhala Baqi Taha (3 hrs)**

19. Examinations:

Q/ write the steps for laying out a completely randomized design with three treatments and four replications.

Step 1: Determine the **total number** of **experimental units**.
Step 2: Assign a **plot number** to each of the **experimental units** starting from **left** to **right** for all rows.
Step 3: Assign the **treatments** to the **experimental units** by using **LOTEERY PLAN** (random numbers).
Step 4:
The **statistical model** for CRD with one observation per unit
$\mathbf{Y_{ij} = \mu + t_i + e_{ij}}$
μ = overall mean effect
$\mathbf{t_i}$ = **true effect** of the **ith** treatment
$\mathbf{e_{ij}}$ = **error** term of the **jth** unit receiving **ith** treatment

Y12			
Y13	Y11		

The arrangement of data in CRD is as follows:

Y11	Y21	Y31	Yi1	
Y12	Y22	Y32	Yi2	
Y13	Y23	Y33	Yi3	
Y1j	Y2j	Y3j	Yij	
Y1	Y2	Y3	Yi	Y.. Grand Total (**GT**)

Step 5: putting a hypothesis
The **null hypothesis** will be
Ho: $\mu_1 = \mu_2 = \ldots\ldots\ldots\ldots = \mu_k$ or There is **no significant difference** between the treatments
And the **alternative** hypothesis is
$\mathbf{H_1}$: μ1 ≠ μ2≠ ……≠ μk. There is **significant difference** between the treatments
Step 6:
The different steps in forming the analysis of variance table

Q/ if you are given the following information obtained from the data of a glass house experiment;

- ∑A, ∑B, ∑C, ∑D & ∑E = 25, 45, 50, 60 and 35 respectively.
- df error= 20
- Tabulated t (∞, df error) = 1.725.

Compare all possible pairs of treatment means using Least significant difference test (LSD test). MS error= 8.06
Answer:
Df E= tr-t
20= 5r – 5
5r= 25
r= 5
A-= 25/5= 5
B-= 45/5= 9
C-= 50/5= 10
D-= 60/5=12
E-= 35/5= 7

$\boldsymbol{LSD = t\ (L.S\ and\ df\ E) * \sqrt{\frac{2MSE}{r}}}$ $\boldsymbol{LSD} = 1.725 * \sqrt{\frac{2*8.06}{5}} = 3.1$

	D- (12)	C-(10)	B-(9)	E- (7)	A-(5)
A-(5)	7 *	5 *	4 *	2	0
E- (7)	5 *	3	2	0	
B-(9)	3	1	0		
C-(10)	2	0			
D- (12)	0				