Department of: Statistics

College of: Administration & Economics

University of: Salahaddin University - Erbil

Subject: Numerical Analysis

Course Book – (Year 2) 1st semester

Lecturer's name: Nazeera S. Kareem (Assist.Prof. Dr)

Academic Year: 2022/2023

Course Book

1. Course name	Numerical Analysis
2.Lecturer in charge	Nazeera S.Kareem
3.Department/ College	Statistics/ Administration & Economics
4. Contact	e-mail: nazeera.kareem@su.edu.krd nazeera.barznji@gmail.com Tel: (optional)٠٧٥٠٤٨١٢٥٥٠
5. Time (in hours) per week	Theory: 2 hours Practical: 2 hour
6. Office hours	15 hours per week

7. Course code	SAE104
8.Teacher's academic profile	• -BSC(Statistics department)(College Administration & Economics) from (The University of Sulaimania) • -MSC (Statistics department)(College Administration & Economics) from (The University of Salahaddin-Erbil)(2001) • -PHD (Statistics department)(College Administration & Economics) from the(University of Salahaddin-Erbil) (2015) • -Assistant researcher(College Administration & Economics)1980 • -Assistant lecturer (The University of Salahaddin - Erbil) (2006) • -Lecturer(2015)(The University of Salahaddin -Erbil) • -Assistant Prof.(2019))(The University of Salahaddin - Erbil) • -Teaching from (43) years at the University of Salahaddin -Erbil) **The Subjects that I taught:** -Non Parametric Statistical test (Master- Statistics department) **-**(Numerical Analysis with R programing Language --2nd Stage) (Statistics department) (Numerical Analysis --2nd Stage) (Statistics department) - (Advanced Statistics--2^{nd}Stage) (Economics department)

-(Principle of Statistics--1st Stage)(Economics department)

-(Principle of Statistics--1stStage) (Administration department)

-(Computer- M.S. Excel)-- 2nd Stage)

(Administration department)

-(Principle of Mathematics--1stStage) (Finance and Banks department)

-(Academic Debate --1st Stage) (Statistics department)-

-(Methodical Research --4st Stage) (Statistics department)-

- **The researches that I had accomplished**

1-PhD (A Dissertation) about [Genetic Effects using R-QTL Statistical Analysis after Chemical Attack on Survivors in Halabja- kurdistan

2- MSC(Thesis) Statistical Study in Analyzing the Chemical Structure of Some Carbonic Rocks in Kurdistan-Iraq

3- (Women and education)for-conference about the reality of women (in the global women's day) it took 3 days (3 / 11-8 / 2008)

4- (University leadership) in conference the Ministry of Higher Education and Scientific research 2008

5- (Using Entropy in Kurdish poetry(homeland) from poet Fayaq Bekas in work shop for World Statistics Day(20/10/2015)

6- construction robust simple linear regression profile monitoring Simulation study (7/3/2017)

7-Logistic Regression and Discriminant analysis to identify the risk of Diabetes

8- De-noise data by using Multivariate Wavelets

in the Path analysis with application

9-Constructing Mathematical Models, by Interpolation Methods, of people's interest to listening to Quran's voice or music   10-

10-De-noise data by using Multivariate Wavelets in

    the Path analysis with application

11ـالتنبؤبالرقم القياسي ومعدل التضخم لإقليم كوردستان العراق بإستخدام نموذج حركي للشبكات العصبية مع السلاسل الزمنية

12- Assessing by Model Fitting Criteria and comparing between Stirling and Aitken interpolation formulas to determine the preferred treatment of choice, (surgery) or (surgery with chemotherapy), for lung cancer in Kurdistan

13- Utilizing Cox Regression Analysis and Bootstrapping

Test for Indicating the Risk of Smoking on Health in Kurdistan

14- Estimating Parameters and Predicting the Risk of Miscarriage, Infertility, and Psychological Disorders Among Chemical Attack Survivors of Kurdistan by Using Multinomial Logistic Regression Analysis

Languages

-Kurdish the mother language

  -English

  -Arabic

9. Keywords	Numerical Analysis [Errors, Equation's Root-finding, Newton-Raphson single, Secant Method,Newton-Raphson(system), Polynomials,Power Series(Taylor and maclurian Series),

10. Course overview:

Numerical analysis A branch of mathematics/computer science dealing with the study of algorithms for the numerical solution of problems formulated and studied in other branches of mathematics. Numerical Analysis is an applied mathematics technique that allows staggeringly large amount of data to be processed and analyzed for trends, thereby aiding in forming conclusions .Providing massive increases in speed and usefulness of calculations. The tasks of numerical analysis: First specialized in mathematical methods of analysis include the development of fast and reliable numerical methods together with the provision of a suitable error analysis and it concerned with all aspects of the numerical solution of a problem, from the theoretical development and understanding of numerical methods to their practical implementation as reliable and efficient computer programs. Such problems originate generally from real-world applications of algebra, geometry and calculus , which they involve variables which vary continuously, these problems have led to an increasing use of realistic mathematical models in science and engineering, and now it plays a central role in the quantitative parts of pure and applied science ,the natural sciences, social sciences, medicine, and business. Second with computer science numerical analysis software is being embedded in popular software packages, e.g. spreadsheet programs, allowing many people to perform modeling even when they are unaware of the mathematics involved in the process.

This requires creating reliable, efficient, and accurate numerical analysis software; and it requires designing problem solving environments (PSE) in which it is relatively easy to model a given situation. Matlab provides many routines for standard tasks in computing, ranging from elementary math operations, over linear algebra, statistics and random numbers, interpolation, optimization, Fourier analysis and filtering, sparse matrix computation, to computational geometry. More information can be found, as always, in the Matlab documentation History Numerical algorithms are at least as old as the Egyptian Rhind papyrus (c. 1650 BC), which describes a root-finding method for solving a simple equation. Ancient Greek mathematicians made much further advancement in numerical methods. In particular, Eudoxus of Cnidus (c. 400– 350 BC) created and Archimedes (c. 285–212/211 BC) perfected the method of exhaustion for calculating lengths, areas, and volumes of geometric figures. When used as a method to find approximations, it is in much the spirit of modern numerical integration; and it was an important precursor to the development of calculus by Isaac Newton (1642–1727) and Gottfried Leibniz (1646–1716). Linear interpolation was already in use more than 2000 years ago. Before the advent of modern computers numerical methods often depended on hand interpolation in large printed tables. Since the mid 20th century, computers calculate the required functions instead. Numerical analysis naturally finds applications in all fields of engineering and the physical sciences, but in the 21st century also the life sciences and even the arts have adopted elements of scientific computations. Ordinary differential equations appear in celestial mechanics (planets, stars and galaxies), numerical linear algebra is important for data analysis of stochastic differential equations and Markov chains are essential in simulating living cells for medicine and biology.

11. Course objective:

The overall goal of the field of numerical analysis is the design and analysis of techniques to give approximate but accurate solutions to hard problems, The broad objectives are to learn about existence and uniqueness criteria for numerical methods, to learn about convergences

criteria. The specific objectives of the course are the student should be able to the variety of theorems and mathematical applications which they suggested in the following statements:

1- Apply several methods about error's theorem

2-Find numerical approximations to the roots of an equation by Newton method, Secant Method.

3- Polynomial

4- Apply Taylor and Maclaurian Series to mathematical problems.

12. Student's obligation

The role of students and their obligations

1-The student attendance to lecture at the time and place as scheduled

by the head of department

2- Preparing the home work

3- Solving the problem(exercise) on the whiteboard by the students

4- The student is ready for the sudden exam on the material is described before (Most of the homework exercises will come after explaining theorems or applications).

5- Enquiry the student of topics mysterious and unintelligible in leisure time of lecturer

6- Preparing the student for daily tests (quiz) after clarify and explain Article The main technique will be used in the lectures. At the beginning of each lecture I will inquire students if they were reading the previous lecture by 5 Minutes (quiz).

7-After complementing explaining the lecture I encourage student to ask questions if they are unable to ask their questions in class, then they may ask outside of class in any time I am in the office.

13. Forms of teaching

To accomplish acceptable outcome the lecturer use several methods to explain and clarify the lecture

1-   Power point presentation for, title of theorem, definitions, graph, results general formula, Exercises.

2- Use Data Show to view PowerPoint representation.

3-White board using to prove theories and solutions for examples or exercise**.**

14. Assessment scheme

The students Supposed to do at least (4) times examination in the first and second courses for up to 40 degrees and to do the final exam on 60 degrees. The lecturer will divide the degrees as follow:

Central exam of first course   10%

Central exam of second course   10%

Daily students activity(quiz, homework , attendance, Student participation in solving problems   on the whiteboard,)   20%

final exam   60%

15. Student learning outcome:

It is well-known that the use of numerical methods for the analysis systems has been increasing at a rapid rate. Therefore, this course is intended to better prepare future computational scientists, in understanding the fundamentals of numerical methods, especially their application, limitations, and potentials. The course will cover the classical fundamental topics in numerical methods the viewpoint will be modern, with connections made between each topic and a variety of applications. By the end of the course, the student should not only be familiar, but more confident, in effectively using numerical tools to solve problems in their own field of interest. In particular, the students will become proficient in: Understanding the theoretical and practical aspects of the use of numerical methods implementing numerical methods for a variety of multidisciplinary applications establishing the limitations,

advantages, and disadvantages of numerical methods the expected learning outcomes for the course will be assessed through: Exams, home works, in- class activities and class discussions. In this course, the emphasis will be to apply well-known numerical techniques to solve engineering problems and evaluate the results. The objective will be to train students to understand why the methods work, what type of errors to expect, and when an application might lead to difficulties. In particular, the students will become proficient in:

The expected learning outcomes for the course will be assessed through: Exams, home works, in- class activities and class discussions. 1.Understanding the theoretical and practical aspects of the use of numerical methods

2.Implementing numerical methods for a variety of multidisciplinary applications

3.Establishing the limitations, advantages, and disadvantages of numerical methods

4. The students should be able to select from alternative methods the one method that is most appropriate for a specific problem.

5. The students should be able to formulate algorithms to solve problems numerically.

6. They should understand the limitations of each numerical method, especially the conditions under which they fail to converge to a solution.

The use of Numerical analysis and mathematical modeling have become essential in many areas of modern life in the list of immense and extends across most major disciplines and fields of work .

1-Advanced numerical methods are essential in making numerical weather prediction feasible. weather, monitor climate change,

2-It is used to predict pick out stock market trends, compute actuarial data Insurance companies use numerical programs for actuarial analysis.

3- Computing the trajectory of a spacecraft requires the accurate numerical solution of a system of ordinary differential equations.

4- Car companies can improve the crash safety of their vehicles by using computer simulations of car crashes. Such simulations essentially consist of solving partial differential equations numerically.

5- Hedge funds (private investment funds) use tools from all fields of numerical analysis to attempt to calculate the value of stocks and derivatives more precisely than other market participants.

6- Airlines use sophisticated optimization algorithms to decide ticket prices, airplane and crew assignments and fuel needs. Historically, such algorithms were developed within the overlapping field of operations research.

7- Numerical Analysis is an applied mathematics technique that allows staggeringly large amount of data to be processed and analyzed for trends, thereby aiding in forming conclusions providing massive increases in speed and usefulness of calculations.

8- Ordinary differential equations appear in celestial mechanics (planets, stars and galaxies)

17. The Topics:	Lecture
Chapter One **1- Errors** **1-1 Definition of Error** **1-2 Sources of Errors** **1-2-1Non-numerical Errors** a- Modeling errors b- Blunders and mistakes c- Uncertainty in information and data **1-2-2 Numerical Errors** a- Truncation errors b- Round-off errors c- Absolute Error d-The Relative True Error e- Initial Error: f- Propagation errors g-Mathematical- approximation errors , Sources of Approximation[perturbation series] h- Inherent Error [**Exercises**]	(4weeks)
Chapter Two **2- Roots-Finding for Non- Linear Equations** 2-1Newton- Raphson Method [N.R.M] for Single Non- Linear Equations [Proof and Example] 2-1-1 Applications of [N.R.M] for making the Equation to finding Several Types of Numbers	6weeks

2-1-1-1 Equation to Finding the Square Root of number by [N.R.M] [Proof and Example] 2-1-1-2Equation to Finding the Reciprocal of number by [N.R.M] [Proof and Example] 2-1-1-3 Equation to Finding the Reciprocal of Square Root of number by [N.R.M] [Proof and Example] 2-2 Secant Method [Proof and Example] 2-3Newton-Raphson Method [N.R.M] for System of Non- Linear Equations [Proof and Example] 2-4 Bisection Method [Proof and Example] 2-5 False Position [Proof and Example] **Exercises**	
Chapter Three **3- Polynomials** 3-1 Polynomials [Definition] 3-2Types of Polynomials [Proof and Example] 3-3 Degrees of polynomials [Proof and Example] 3-4Evaluation of Polynomials [Proof and Example] 3-5Representation Polynomial by power algebraic series [Proof and Example] **Exercises**	(2weeks)
Chapter Four **4-Power Series [Power Expansion]** 4-1Taylor series [Taylor Expansion] [Proof and Example] 4-2Maclaurian series [Maclaurian Expansion] ([Proof and Example] **Exercises**	(3weeks)

19. Examinations:

(Applied or Practical) This type of tests are depend on the basis that the questions include practical   issues to be resolved based on the theories and applications or equations which will be used by students through: home works, in-class activities ,class discussion and exams, during the year.

20. Extra notes:

Add paragraph about the existence of scientific and intellectual relationship between the lecturers of the same lecture in different colleges to develop curriculum and exchange ideas about what is happening in the scientific and intellectual developments.

21. Peer review: