Department of …Statistics….

College of ……Adm. & Eco…….

University of… SALAHADDIN UNIVERSITY – HAWLER …….

Subject: ……Probability Distribution…….

Course Book – (Year 3)

Lecturer's name: Asst.Prof. Dr.Dler Hussein Kadir (PhD)

Academic Year: 2022/2023

Course Book

1. Course name	Mathematical Statistics
2. Lecturer in charge	Asst. prof. Dr. Dler Hussein Kadir
3. Department/ College	Statistics /Adm. & Eco.
4. Contact	e-mail: dler.kadir@su.edu.krd Tel: (optional)
5. Time (in hours) per week	Theory: 2 Practical: 1
6. Office hours	Availability of the lecturer to the student during the week
7. Course code	
8. Teacher's academic profile	From 2007 until 20011 worked as Assistant Lecturer in Statistics Department – Salahaddin University. In 2007 I had my MSc. in Statistics from the Sulimanya university. In 2018 I had my PhD in Statistics from the Sheffield University – Sheffield – UK. During my presence in this field, I have taught the following subject: Statistics, Probability, and Mathematical Statistics
9. Keywords	PDF, CDF, J.P.D.F, Statistical Distributions, Transformation.

10. Course overview:

Statistics is an attractive and useful subject. Every time you open a website, newspaper, read an article or listen to a new report you can find examples of statistics in your everyday world. Most students find "Elementary of statistics" subject very interesting and are pleasantly surprised at how different it is from other courses.

This course is designed primarily for third class students in order to have basic information about how to use statistical distributions through mathematics. There will be a heavy emphasis on discrete and continuous distributions. The focus will be on understanding how to use and interpret the statistical problems.

Statistical methods used in practice are based on a foundation of statistical theory. One branch of this theory uses the tools of probability to establish important distributional results that are used throughout statistics. Another major branch of statistical theory is statistical inference which will be studied at fourth class. It deals with issues such as how do we define a "good" estimator or hypothesis test, how do we recognise one and how do we construct one? This course is concerned with the fundamental theory of random variables and statistical distributions.

11. Course objective:

The general purpose of this course is to study the basic concepts of probability distributions and transformation of random variables in order to help students learn and understand some fundamental rules in Mathematical Statistics and knowing where and how they are used in the life. So that preparing them with in-depth learning principles of random variables and their properties, including marginal and conditional distributions, expectation, conditional expectation, covariance and correlation, moment generating functions, distributions of functions of one or more random variables, recognize the properties of important probability distributions, and distribution of transformations. After taking this course,

students will be prepared studying an important subject which is called "Statistical Inferences" in the 4th class.

12. Student's obligation

Students are expected to:

- ❖ Follow university policies when attending class and lab, and taking quizzes and exams.
- ❖ Bring stationery to class.
- ❖ Bring scientific calculator to class.
- ❖ Be on time to class!
- ❖ 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

A course with a large proportion of its teaching taking place in lectures will need to have a high level of essential interest to students to keep them engaged. There are lots of talks about what is good teaching technique in academic circle, they often come out with different forms such as: classical teaching with blackboard, power point presentations for the head titles and definitions and summary of conclusions, classification of materials and any other illustrations, students will be asked to prepare reports on statistical topics and they should participate as much as possible in lecture's discussions. Also, it is useful to fulfill some seminars by students to encouraging them learning and discussing the subject without lecturer.

14. Assessment scheme

The students are obliged to perform at least two closed book exams during the academic year. The exam has 30%, besides homework, quizzes, and classroom activities – 10%, reports (if exists) – 5%. The other 60% will be reserved for the final exam. Therefore, the final grade will be based upon the following criteria:

Homework and interactive activities : 10% - 15%
Theoretical Exam : 25% - 30%
Final Exam: 60%

15. Student learning outcome:

The students learning outcome will be a heavy understanding of statistical distributions with their properties and preparing them for the 4^{th} class especially to start with the statistical inference subject. Therefore, it is very important to have all the subjects which are pretended to take in this course. In another hand, without taking this course, students could not have good understanding for the subjects of the next stage or class.

16. Course Reading List and References:

1) Dennis D. Wackerly & others, Mathematical Statistics with Applications, 7th ed., 2008.
2) Richard J. Larsen, Morris L. Marx, Introduction to Mathematical Statistics and its Application, 4th ed., 2006.
3) Hogg, V. R., Craig, A. T., McKean, J. W. Introduction to Mathematical Statistics, 6th ed., 2004.
4) Jun Shao, Mathematical Statistics, 2nd ed., 2003.
5) Sheldon Ross, A First Course in Probability, 6th ed., 2002.
6) Hogg, V. R., Craig, A. T., McKean, J. W. Introduction to Mathematical Statistics, 4th ed., 1983.
7) Mood, A. M., Graybill, F. A., Boes, D. C., Introduction to the theory of statistics, McGraw-Hill Pub. 3rd ed., 1974.

17. The Topics:	Lecturer's name
Introduction to Probability and Basic Statistical review - Random Variable - Types of Random Variables - Probability (Mass & Density) Function - The Mode - The Median - The Cumulative Distribution Function (c.d.f) - Exam in Chapter One **Discrete Probability Distributions** - Discrete Uniform Distribution - Bernoulli Distribution - Binomial Distribution - Poisson Distribution - Geometric Distribution - Negative Binomial Distribution - Hyper Geometric Distribution - Other Distribution **Continuous Probability Distribution** - Continuous Uniform Distribution - Beta Distribution - Gamma Distribution - Exponential Distribution - Chi – Square Distribution - Weibull Distribution - Other Distribution - Normal Distribution - Exam **Transformation** - Transformation of Discrete type - Transformation of Continuous type - Order Statistics	Dr. Dler Hussein Kadir
18. Practical Topics (If there is any)	

19. Examinations:

1. Compositional

Q1/ Let X be a *r.v.* and $E(x) = 4$, $E(x)^2 = 20$. 5 marks

Use Chebyshev's inequality to determine lower bounded for the probability $P(-2< X <8)$

Q2/ Let $f(x)=\begin{Bmatrix} e^{-x} & 0<x<\infty \\ 0 & o.w \end{Bmatrix}$ *be the p.d.f of X. Find* $M_X(t)$ *of X and* m_2

5 marks

Q3/ Let X be a discrete r. v. and the c.d.f. is as follows: 5 marks

$$F(x)=\begin{cases} 0 & x<1 \\ \frac{1}{15} & 1\le x<2 \\ \frac{3}{15} & 2\le x<3 \\ \frac{6}{15} & 3\le x<4 \\ \frac{10}{15} & 4\le x<5 \\ 1 & 5\le x \end{cases}$$

find the p.d.f .

Q4/ Find the median of the following distribution $\boldsymbol{f(x)=\begin{Bmatrix} 3(1-x)^2 & 0<x<1 \\ 0 & o.w \end{Bmatrix}}$ 5 marks

Q5/ Find the let X be a r.v. with $\boldsymbol{f(x)=\begin{Bmatrix} 3x^2 & 0<x<3 \\ 0 & o.w \end{Bmatrix}}$. Find P(X<10) and P(X<2)

5 marks

Q6/ Select the best answer or fill the blanks of the following statements: **12 Marks**

1. If $f(x)=\begin{Bmatrix} x/15, & x=1,2,3,4,5 \\ 0, & otherwise \end{Bmatrix}$, then P(1/2< X < 5/2) = _____. **1.5 Mark**

a.) 1/8 b.)1/7 c.)1/6 d.)1/5 e.)None.

2. If $f(x)=\begin{Bmatrix} a\binom{2}{x}, & x=0,1,2 \\ 0, & otherwise \end{Bmatrix}$, then the value of **a** is_____. **1 Mark**

a.) 1/6 b.)1/5 c.)1/4 d.)1/2 e.)None.

3. If $f(x)=\begin{Bmatrix} \frac{2x}{3}, & 0<x<1 \\ 0, & otherwise \end{Bmatrix}$, then E(x)=_____. **1.5 Mark**

a.) 2/9 b.)1 c.)1/9 d.)5/9 e.)None.

4. If $f(x)=\begin{Bmatrix} ae^{-2x}, & 0<x<\infty \\ 0, & otherwise \end{Bmatrix}$, then the value of **a** is_____. **1.5 Mark**

a.) 1/2 b.)1 c.)3/2 d.)2 e.)None.

5. If E(x)=1/2 and E(x^2)=1/3, then E(2x+3)=__4___ and V(2x+5)=__1/3___. **1 Mark**

6. X and Y are called independent if _____. **0.5 Mark**

7. If the p.d.f. of x is as follows: $f(x)=\begin{cases}\frac{3^x e^{-3}}{x!} & x=0,1,2,\dots\\ 0 & o.w\end{cases}$, then the mode equals to _____. **1.5 Mark**

a.) 1 b.)2 c.)3 d.)2 and 3 e.)None.

8. The median of the following distribution $f(x)=\begin{cases}3x^2 & 0<x<1\\ 0 & o.w\end{cases}$ is_____. **1.5 Mark**

a.) 1 b.)2 c.)$\sqrt{1/2}$ d.)1/2 e.)None.

9. F(-∞)=_____. **0.5 Mark**

10. Let X be a r.v. with the p.d.f. $f(x)=\begin{cases}1 & 0<x<1\\ 0 & o.w\end{cases}$, then the m.g.f. of X is _____. **1.5 Mark**

a.) $\frac{e^t-1}{t}$ b.) $\frac{te^t-1}{t}$ c.) $\frac{e^t}{t}$ d.)1 e.)None.

Q2/ Let X be a r.v. having p.d.f . 7 Marks

$$f(x)=\begin{cases}\frac{1}{2\sqrt{x}} & 0<x<\frac{1}{4}\\ \frac{1}{4\sqrt{x}} & \frac{1}{4}<x<\frac{9}{4}\\ 0 & o.w\end{cases}$$

$$find\ the\ c.d.f\ of\ x.\ \&\ \Pr\left(\frac{1}{16}<x<\frac{1}{2}\right)$$

Q7

Let x be a r.v. with p.m.f. of P(x);

$$P(x)=\begin{cases}\left(\frac{1}{2}\right)^{x+1} & x=0,1,2,\dots\\ 0 & o.w\end{cases}$$

Find:

1- Check P(x) is a p.m.f

2- $\Pr(x\geq 2)$

3- $\Pr(0<x<3)$

4- $\Pr(2 < x \leq 4)$

5- $\Pr(2 \leq x \leq 5)$

Result:

1- $\sum_0^\infty \left(\frac{1}{2}\right)^{x+1} = \frac{1}{2}\sum_0^\infty \left(\frac{1}{2}\right)^{x} = \frac{1}{2}\left(\frac{1}{1-\frac{1}{2}}\right) = 1 \quad \therefore p(x)$ is a p. m. f

2- $p(x \geq 2) = \frac{1}{4}$ **3-** $p(0 < x < 3) = \frac{3}{8}$ **4-** $p(2 \leq x \leq 5) = \frac{15}{64}$ **5-** $p(2 < x \leq 4) = \frac{3}{32}$

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.

21. Peer review

Dr. Saman Husein Mahmoud

Dr. Rizgar Magdid Ahmed