University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of Probability and Statistics for Engineers

Course Code (BR231)

I. Course Identification and General Information:

1	**Course Title:**	Probability and Statistics for Engineers				
2	**Course Code & Number:**	BR231				
3	**Credit hours:**	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	--	--	--	2
4	**Study level/ semester at which this course is offered:**	3rd Level / 1st Semester				
5	**Pre –requisite (if any):**	BR121				
6	**Co –requisite (if any):**	None				
7	**Program (s) in which the course is offered:**	Biomedical Engineering Program				
8	**Language of teaching the course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Associate Prof. Dr. Khalil Al-Hatab				
11	**Reviewed by:**	Dr. ----				
12	**Date of Approval:**					

II. Course Description:

Introduces basic concepts in statistics and probability and shows how real-world problems can be solved with emphasis on biomedical engineering applications. It covers the following topics: describing data graphically and numerically, elements of probability, discrete and continuous random variables and their probability distributions, distribution functions of random variables, sampling distributions, estimation of population parameters and hypothesis testing, linear regression analysis, factorial designs,

and statistical quality control (SQC).

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		**Referenced PILOs** (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Recognize the basic concepts and terminology of probability and statistics, which are used as a very appropriately tools in manage, organize and display of data relevant to real life problems.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Describe the discrete and continuous distributions and descriptive measures and how to use them to calculate probabilities and to reduce data sets into a few useful, descriptive measures.	A2 Clarify the design principles and techniques and the engineering materials characteristics and how these are relevant to the developments and technologies in a biomedical systems context.
a3	Understand how the central theorem, measures of variation, distributions types, hypothesis tests, design of experiments and regression analysis are used in engineering applications to make predictions.	A4 Understand and give examples of design methods, knowledge tools, analytical skills, measurement techniques and methodologies for innovative and creative engineering solutions applied to healthcare problems and quality of life issues.
B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Analyze, calculate and interpret of total variation in a data set, central tendency and dispersion measures, probabilities, regression coefficients, z, t, F, and chi-square test statistics to	B2 Identify, formulate and solve the complex problems related to the Biomedical Engineering fields in a creative and innovative manner by using a systematic and

	make statistical inferences for real-world problems.	analytical thinking methods.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Apply the estimation, hypothesis testing, variance, regression and correlation concepts of probability and statistics for small and large data analysis in Biomedical Engineering fields.	C1 Apply integrally knowledge of mathematics, life science, IT, design, business context and engineering practice to solve problems and to design systems/processes relevant to Biomedical Engineering.
c2	Use hypothesis and comparison tests and appropriate computers software in the statistical analysis of data relevant to problems in the biomedical systems context.	C3 Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, collect, analyse and interpret data and present results in the biomedical systems practice.
c3	Demonstrate basic organizational and data management skills and have the notion of sampling distributions and statistical techniques used in real-life problems.	C5 Demonstrate basic organizational and project management skills, apply quality assurance procedures, practice neatness and aesthetics and follow codes and standards to improve biomedical products design or services.
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Recognize the basic concepts and terminology of probability and statistics, which are used as a	• Interactive lectures & examples,	• Written tests (mid and final terms and quizzes),

very appropriately tools in manage, organize and display of data relevant to real life problems.	• Interactive class discussions, • Exercises and home works,	• Coursework activities assessment, • Home works and assignments,
a2. Describe the discrete and continuous distributions and descriptive measures and how to use them to calculate probabilities and to reduce data sets into a few useful, descriptive measures.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,
a3. Understand how the central theorem, measures of variation, distributions types, hypothesis tests, design of experiments and regression analysis are used in engineering applications to make predictions.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Analyze, calculate and interpret of total variation in a data set, central tendency and dispersion measures, probabilities, regression coefficients, z, t, F, and chi-square test statistics to make statistical inferences for real-world problems.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies

c1. Apply the estimation, hypothesis testing, variance, regression and correlation concepts of probability and statistics for small and large data analysis in Biomedical Engineering fields.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,
c2. Use hypothesis and comparison tests and appropriate computers software in the statistical analysis of data relevant to problems in the biomedical systems context.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,
c3. Demonstrate basic organizational and data management skills and have the notion of sampling distributions and statistical techniques used in real-life problems.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
		•

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	**Introduction to**	**a1,a2,a3, b1,c1,c2,c3**	– Course Overview – Introduction	**1**	**2**

	Statistics		– Some Basic Concepts – Measurement and Measurement Scales – Sampling and Statistical Inference – Scientific Method and Design of Experiments – Computers and Statistical Analysis in Biomedical Applications		
2	**Descriptive Statistics**	**a1,a2,a3, b1,c1,c2,c3**	– Describing data sets – Summarizing data sets – Chebyshev's inequality – Normal data sets – Paired data sets and the sample correlation coefficient – The Lorenz curve and Gini index	**2**	**4**
3	**Some Basic Probability Concepts**	**a1,a2,a3, b1,c1,c2,c3**	– Two Views of Probability: Objective and Subjective – Elementary Properties of Probability – Calculating the Probability of an Event – Bayes' Theorem, Screening Tests, Sensitivity, Specificity, and Predictive Value Positive and Negative	**1**	**2**
4	**Probability Distributions**	**a1,a2,a3, b1,c1,c2,c3**	– Probability Distributions of Discrete Variables – Binomial Distribution – Poisson Distribution – Continuous Probability Distributions – Normal Distribution – Normal Distribution Applications	**2**	**4**
5	**Some Important Sampling Distributions**	**a1,a2,a3, b1,c1,c2,c3**	– Sampling Distributions – Distribution of The Sample Mean – Distribution of The Difference Between Two Sample Means – Distribution of The Sample Proportion – Distribution of The Difference Between Two Sample Proportions	**1**	**2**
6	**Mid-Term Theoretical Exam**	**a1,a2,a3, b1,c1,c2,c3**	– All Previous Topics	**1**	**2**

7	**Estimation**	**a1,a2,a3, b1,c1,c2,c3**	– Confidence Interval for a Population Mean – The t-Distribution – Confidence Interval for the Difference Between Two Population Means – Confidence Interval for a Population Proportion – Confidence Interval for the Difference Between Two Population Proportions – Determination of Sample Size for Estimating Means and Proportions	**1**	**2**
8	**Hypothesis Testing**	**a1,a2,a3, b1,c1,c2,c3**	– Hypothesis Testing: A Single Population Mean – Hypothesis Testing: The Difference Between Two Population Means – Paired Comparisons – Hypothesis Testing: A Single Population Proportion – Hypothesis Testing: The Difference Between Two Population Proportions – The Type II Error and The Power of a Test – Determining Sample Size to Control Type II Errors	**2**	**4**
9	**Analysis of Variance**	**a1,a2,a3, b1,c1,c2,c3**	– The Completely Randomized Design – The Randomized Complete Block Design – The Repeated Measures Design – The Factorial Experiment	**2**	**4**
10	**Simple Linear Regression and Correlation**	**a1,a2,a3, b1,c1,c2,c3**	– The Regression Model – The Sample Regression Equation – Evaluating the Regression Equation – Using the Regression Equation – The Correlation Model – The Correlation Coefficient – Some Precautions	**1**	**2**
11	**Statistical Quality control (SQC)**	**a1,a2,a3, b1,c1,c2,c3**	– $\bar{x}$ Control Charts – S-Control Charts – Control Charts for the Fraction	**1**	**2**

			Defective – Control Charts for Number of Defects		
12	**Final Theoretical Exam**	**a1,a2,a3, b1,c1,c2,c3**	– All Topics	**1**	**2**
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect: (if any)

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1				
Number of Weeks /and Units Per Semester			**15**	**30**

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1				
Number of Weeks /and Units Per Semester				

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Interactive class discussions,
- Exercises and home works,

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Coursework activities assessment,
- Home works and assignments,

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	**Homework (10 sets)**	**a1,a2,a3, b1,c1,c2,c3**	3-13	10
Total				10

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	**Assignments**	3-13	10	10%	**a1,a2,a3, b1,c1,c2,c3**
2	**Quizzes**	6, 12	10	10%	**a1,a2,a3, b1,c1,c2,c3**
3	**Midterm Theoretical Exam**	8	20	20%	**a1,a2,a3, b1,c1,c2,c3**
4	**Final Theoretical Exam**	16	60	60%	**a1,a2,a3, b1,c1,c2,c3**
Total			100	100%	

IX. Learning Resources:

1- Required Textbook(s) (maximum two).

1. Wayne W. Daniel and Chad L. Cross, 2013, **Biostatistics A Foundation for Analysis in the Health Sciences**, 10th Edition, USA, John Wiley & Sons, Inc.

2- Essential References.	
	1. Johnson, R.A., Miller, I and Freund J., 2015, **Probability and Statistics for Engineers**, 8th Edition, Asia, Pearson Education. 2. Milton. J. S. and Arnold. J.C., 2007, **Introduction to Probability and Statistics**, 4th Edition, India, Tata McGraw Hill. 3. Devore. J.L., 2014, **Probability and Statistics for Engineering and the Sciences**, 8th Edition, New Delhi, Cengage Learning. 4. Ross, S.M., 2004, **Introduction to Probability and Statistics for Engineers and Scientists**, 3rd Edition, Elsevier. 5. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., 2004, **Schum's Outline of Theory and Problems of Probability and Statistics**, Tata McGraw Hill Edition. 6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., 2007, **Probability and Statistics for Engineers and Scientists**, 8th Edition, Asia, Pearson Education.
3- Electronic Materials and Web Sites *etc*.	
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X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam

4	**Assignments & Projects**: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Template for Course Plan (Syllabus)

Probability and Statistics for Engineers
BR231

I. Course Identification and General Information:						
1	**Course Title:**	Probability and Statistics for Engineers				
2	**Course Code & Number:**	BR231				
3	**Credit Hours:**	**Credit Hours**	**Theory Hours**		**Lab. Hours**	
			Lecture	**Exercise**		
		2	2	--	--	
4	**Study Level/ Semester at which this Course is offered:**	3rd Level / 1st Semester				
5	**Pre –Requisite (if any):**	BR121				
6	**Co –Requisite (if any):**	None				
7	**Program (s) in which the Course is Offered:**	Biomedical Engineering Program				
8	**Language of Teaching the Course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Associate Prof. Dr. Khalil Al-Hatab				
11	**Reviewed by:**	Dr. ----				
12	**Date of Approval:**					

II. Course Description:

Introduces basic concepts in statistics and probability and shows how real-world problems can be solved with emphasis on biomedical engineering applications. It covers the following topics: describing

data graphically and numerically, elements of probability, discrete and continuous random variables and their probability distributions, distribution functions of random variables, sampling distributions, estimation of population parameters and hypothesis testing, linear regression analysis, factorial designs, and statistical quality control (SQC).

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Recognize the basic concepts and terminology of probability and statistics, which are used as a very appropriately tools in manage, organize and display of data relevant to real life problems.
a2	Describe the discrete and continuous distributions and descriptive measures and how to use them to calculate probabilities and to reduce data sets into a few useful, descriptive measures.
a3	Understand how the central theorem, measures of variation, distributions types, hypothesis tests, design of experiments and regression analysis are used in engineering applications to make predictions.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Analyze, calculate and interpret of total variation in a data set, central tendency and dispersion measures, probabilities, regression coefficients, z, t, F, and chi-square test statistics to make statistical inferences for real-world problems.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Apply the estimation, hypothesis testing, variance, regression and correlation concepts of probability and statistics for small and large data analysis in Biomedical Engineering fields.
c2	Use hypothesis and comparison tests and appropriate computers software in the statistical analysis of data relevant to problems in the biomedical systems context.
c3	Demonstrate basic organizational and data management skills and have the notion of sampling distributions and statistical techniques used in real-life problems.
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	????????

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction to Statistics**	– Course Overview – Introduction – Some Basic Concepts – Measurement and Measurement Scales – Sampling and Statistical Inference – Scientific Method and Design of Experiments – Computers and Statistical Analysis in Biomedical Applications	**1**	**2**
2	**Descriptive Statistics**	– Describing data sets – Summarizing data sets – Chebyshev's inequality – Normal data sets – Paired data sets and the sample correlation coefficient – The Lorenz curve and Gini index	**2**	**4**
3	**Some Basic Probability Concepts**	– Two Views of Probability: Objective and Subjective – Elementary Properties of Probability – Calculating the Probability of an Event – Bayes' Theorem, Screening Tests, Sensitivity, Specificity, and Predictive Value Positive and Negative	**1**	**2**
4	**Probability Distributions**	– Probability Distributions of Discrete Variables – Binomial Distribution – Poisson Distribution – Continuous Probability Distributions – Normal Distribution – Normal Distribution Applications	**2**	**4**
5	**Some Important Sampling**	– Sampling Distributions – Distribution of The Sample Mean – Distribution of The Difference Between	**1**	**2**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
	Distributions	Two Sample Means – Distribution of The Sample Proportion – Distribution of The Difference Between Two Sample Proportions		
6	**Mid-Term Theoretical Exam**	– All Previous Topics	**1**	**2**
7	**Estimation**	– Confidence Interval for a Population Mean – The t-Distribution – Confidence Interval for the Difference Between Two Population Means – Confidence Interval for a Population Proportion – Confidence Interval for the Difference Between Two Population Proportions – Determination of Sample Size for Estimating Means and Proportions	**1**	**2**
8	**Hypothesis Testing**	– Hypothesis Testing: A Single Population Mean – Hypothesis Testing: The Difference Between Two Population Means – Paired Comparisons – Hypothesis Testing: A Single Population Proportion – Hypothesis Testing: The Difference Between Two Population Proportions – The Type II Error and The Power of a Test – Determining Sample Size to Control Type II Errors	**2**	**4**
9	**Analysis of Variance**	– The Completely Randomized Design – The Randomized Complete Block Design – The Repeated Measures Design	**2**	**4**

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		– The Factorial Experiment		
10	**Simple Linear Regression and Correlation**	– The Regression Model – The Sample Regression Equation – Evaluating the Regression Equation – Using the Regression Equation – The Correlation Model – The Correlation Coefficient – Some Precautions	1	2
11	**Statistical Quality control (SQC)**	– $\bar{x}$ Control Charts – S-Control Charts – Control Charts for the Fraction Defective – Control Charts for Number of Defects	1	2
12	**Final Theoretical Exam**	– All Topics	1	2
Number of Weeks /and Units Per Semester			**16**	**32**

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	None		
Number of Weeks /and Units Per Semester			

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours
	None		

C. Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
Number of Weeks /and Units Per Semester			

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Interactive class discussions,
- Exercises and home works,

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Coursework activities assessment,
- Home works and assignments,

VII. Assignments:

No.	Assignments	Week Due	Mark
1	**Homework (10 sets)**	3-13	10
Total			**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Assignments**	3-13	10	10%
2	**Quizzes**	6, 12	10	10%
3	**Midterm Theoretical Exam**	8	20	20%

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
4	**Final Theoretical Exam**	16	60	60%
Total			**100**	**100%**

IX. Learning Resources:

- *Written in the following order:*

1- Required Textbook(s) (maximum two):

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