Mathematics I, Mathematics II

Statistics uses mathematical tools to organize and summarize data obtained from the real world, and to draw conclusions derived from a correct interpretation of these data. In the business world, statistics can help assess the attractiveness of a business opportunity, increase customer satisfaction, choose between different investment possibilities, analyze and improve production processes, predict the winner of elections based on political campaigns, etc.

Students following this course will learn how to define the data required in different situations characterized by uncertainty, how to collect and summarize these data, and how to make decisions based on data analysis. This course also provides the theoretical and practical bases for other courses in the degree, such as Econometrics and Social Analysis.

The objective of this course is to provide students with the tools to organize and understand data and to make use of this information in social sciences applications. At the end of the course you should be able to:

- Describe data by means of graphs or figures, understanding in which contexts each of these descriptive tools is useful.
- Understand patterns of randomness and relate them to known probability distributions.
- Understand the differences between population and sample distributions
- Read the most common distribution tables.
- Derive confidence intervals for a parameter.
- Make inferences by understanding the concept of null and alternative hypotheses
- Use statistical methods for decision-making in social sciences.

Additionally, the course will focus on the acquisition or reinforcement of generic skills:
- The ability to summarize and present information in a meaningful way.
- The ability to build an abstract model to address social sciences problems.
- The ability to quickly identify the tools that are useful in social sciences.

**METHODOLOGY**

<table>
<thead>
<tr>
<th>Teaching methodology</th>
<th>Weighting</th>
<th>Estimated time a student should dedicate to prepare for and participate in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>20.0 %</td>
<td>30 hours</td>
</tr>
<tr>
<td>Discussions</td>
<td>6.67 %</td>
<td>10 hours</td>
</tr>
<tr>
<td>Exercises</td>
<td>30.0 %</td>
<td>45 hours</td>
</tr>
<tr>
<td>Group work</td>
<td>30.0 %</td>
<td>45 hours</td>
</tr>
<tr>
<td>Other individual studying</td>
<td>13.33 %</td>
<td>20 hours</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0 %</td>
<td>150 hours</td>
</tr>
</tbody>
</table>
PROGRAM

SESSIONS 1 - 3 (FACE TO FACE)

PRESENTATION AND TOPIC 1
Topic 1: Methods for describing sets of data
Presentation of the programme, aims and guidelines of the course. Introduction to the uses of statistics and the different categories of variables. Presentation of some graphical tools used to summarize data of different types - Histograms, Tables and Charts, etc.
Measures of central tendency and variability: Mean, weighted mean, median, standard deviation, quartiles, skewness, kurtosis. Measures of relationships between variables. Observational studies vs. experiments. Use of Excel for descriptive statistics.
B.C.: Chapter 2
Statistics in action: Case Study 1

SESSION 4 (LABORATORY)
Exercises

SESSION 5 (FACE TO FACE)
SESSION 5: TOPIC 2
Topic 2: Probability
Random experiments, outcomes and events. Computing the probabilities of processes of interest. Joint and marginal probabilities. Conditional probabilities. Bayes' theorem
B.C.: Chapter 3
Statistics in action: Case study 2

SESSION 6 (LABORATORY)
Exercises

SESSIONS 7 - 9
TOPIC 3.
Topic 3: Discrete random variables. Discrete probability distributions
Definition of random variables: Expected value, variance. Mean and variance of linear functions of random variables. Discrete random variables: probability functions and properties (expected value and variance). Binomial, Poisson, and Hypergeometric probability distributions. Jointly distributed discrete random variables: Mean, variance, covariance, and correlation
B.C.: Chapter 4

SESSION 10 (LABORATORY)
Exercises
SESSIONS 11 - 13

TOPIC 4

Topic 4: Continuous random variables. Discrete probability distributions

Definitions and properties. The Normal distribution: Properties, the standard normal distribution, evaluating the normal approximation (histograms and normal probability plots), normal distribution approximation for binomial distribution. Other continuous distributions: Exponential and Uniform. Jointly distributed continuous random variables.

_B.C._: Chapter 4

Statistics in action: Case Study 3

SESSION 14 (LABORATORY)

Exercises

SESSION 15 (LABORATORY)

Mid-term review

SESSION 16 (LABORATORY)

Mid-term

SESSION 17 (FACE TO FACE)

TOPIC 5

Topic 5: Sampling distributions of sample means and sample proportions

Brief introduction to sampling methods. Random samples. Distribution of sample means. Central Limit Theorem. Sampling distributions of sample proportions

_B.C._: Chapter 5

Statistics in action: Case Study 4

SESSION 18 (LABORATORY)

Exercises

SESSIONS 19 - 20

TOPIC 6

Topic 6: Inferences based on a single sample: Estimation with confidence intervals

Point estimation of parameters. Confidence interval for a population mean (large samples, normal distribution). Confidence interval for a population mean (small samples, t distribution). Large sample confidence interval for a population proportion. Determining the sample size.

_B.C._: Chapter 6

Statistics in action: Case Study 5

SESSION 21 (LABORATORY)

Exercises
SESSIONS 22 - 23

TOPIC 7

Topic 7: Inferences based on a single sample: Test of hypotheses
The elements of a test of hypothesis. Formulating null and alternative hypothesis. Observed significance levels: p-values. Test of hypothesis about a population mean: normal (z) statistic. Test of hypothesis about a population mean: Student’s t-statistic. Large-sample test of hypothesis about a population proportion. Type II error.

B.C.: Chapter 7
Statistics in action: Case Study 6

SESSION 24 (LABORATORY)
Exercises

SESSIONS 25 - 27

TOPIC 8

Topic 8: Inferences based on two samples: Confidence intervals and Tests of hypotheses

B.C.: Chapter 8
Statistics in action: Case Study 7

SESSION 28 (LABORATORY)
Exercises

SESSION 29 (LABORATORY)
General review

SESSION 30 (LABORATORY)
Final exam
BIBLIOGRAPHY

All the required readings are from the compulsory textbook “Statistics for Business and Economics”, McClave J.T, Benson P.G. & Sincich T. Pearson Prentice Hall, 13th edition, 2018 (ISBN / ISSN: 978-1-29-222709-9). Reading a section means reading the text AND the examples. You are required to obtain a copy and read the indicated sections in advance, i.e., before each lecture.

The following is a recommended book, “Open Intro Statistics”, Diez, David; Barr Christopher & Cetinkaya-Rundel, Mine, 3rd edition. This book can be used to review some of the topics presented in class, to find extra exercises, etc. The textbook is offered under a Creative Commons license at: https://www.openintro.org/

Visit openintro.org for a free PDF, to download the textbook’s source files, or for more information about the license.

EVALUATION CRITERIA

A. CLASS PARTICIPATION (10%)

Two main criteria will be used in reaching judgment about your class participation:

1-Assistance: Assistance to class is compulsory. (1) Students must comply with the 70% attendance rule. Otherwise they will lose their 1st and 2nd chance, and go directly to the 3rd one (they will need to enrol again in this course next academic year). (2) Punctuality will be taken into consideration when grading this assistance item and the teacher reserves the right to allow attendance to class to those students not being on time. Finally, (3) general attitude and behaviour in class will be also considered. Students affecting the class environment in a negative way will lose points in the assistance grade.

2-Active participation: participation in class will be evaluated positively if students: (1) attain a threshold quantity of contributions that is sufficient for making a reliable assessment of comment quality. Additionally, (2) participation will be evaluated in quality terms. A high quality comment reveals depth of insight, rigorous use of case evidence, consistency of argument, and realism. A high quality presentation of ideas must consider the relevance and timing of comments, and the flow and content of the ensuing class discussion. It demands comments that are concise and clear, and that are conveyed with a spirit of involvement in the discussion at hand.

B. GROUP REPORT (15%)

Each group should be composed of 4 to 5 students and must prepare a group report due at the end of the course (more details about intermediate and final deadline will be periodically provided during the course.) The group project will consist in the identification of a real-world problem, the collection of relevant data, the statistical analysis of the data, and the final interpretation of the obtained results.

Every submission will be delivered using turnitin following the appropriate link provided on campus online. At the end of the semester, you must submit the full report including all sections. The final version should include edited versions of the previously submitted sections following the recommendations of your professor.

Make sure the report is easy to read. Consider using bullets, headings, etc., to make it easy to follow. Avoid being too technical in the report: provide a fact-based rationale for your comments but make sure that your explanations and recommendations are understandable to someone with very little statistical knowledge.

C. QUIZZES (15%)

At the beginning of some sessions, you will be given a short quiz based on required readings and exercises for the session.

D. MID-TERM EXAM (20%)

The mid-term exam will take place around session 15 and will cover Units 1, 2, and 3 of the content of the course.
E. FINAL EXAM (40%)

The final exam will take place in session 30 and will cover all the sessions of the course, from the first session to the last session.

For both the mid-term and the final exam, you must bring your own calculator (phones, tablets, laptops and other electronic devices are not allowed). You are also allowed to bring one sheet—one sided— in the mid-term (two sided in the final exam) with any formula and/or example that you think could be helpful.

In order to pass the course, you need a minimum grade of 3.5 in the final exam. If your grade in the final exam does not reach the threshold value of 3.5, you will fail the course, even in the case in which your weighted average (computed using the table above) exceeds 5.0.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Final Exam</td>
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<tr>
<td>Intermediate Tests</td>
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<td></td>
</tr>
<tr>
<td>Quizzes</td>
<td>15 %</td>
<td></td>
</tr>
<tr>
<td>Group Presentation</td>
<td>15 %</td>
<td></td>
</tr>
<tr>
<td>Class Participation</td>
<td>10 %</td>
<td></td>
</tr>
</tbody>
</table>

RETAKE POLICY

Each student has 4 chances to pass any given course distributed over two consecutive academic years: ordinary call exams and extraordinary call exams (re-sits) in June/July.

Any student whose weighted final grade is below 5 will be required to sit for the retake exam to pass the course. Students who do not comply with the 70% attendance rule during the semester will fail both calls for this Academic Year (ordinary and extraordinary) and have to re-take the course (i.e., re-enroll) in the next Academic Year.

Evaluation criteria will be subject to the following rules:

- Students failing the course in the ordinary call (during the semester) will have to re-sit the exam in June / July (except those not complying with the attendance rule, who will not have that opportunity and must directly re-enroll in the course on the next academic year).

- The extraordinary call exams in June / July (re-sits) require your physical presence at the campus you are enrolled in (Segovia or Madrid). There is no possibility to change the date, location or format of any exam, under any circumstances. Dates and location of the June / July re-sit exams will be posted in advance. Please take this into consideration when planning your summer.

- The June / July re-sit exam will consist of a comprehensive exam. Your final grade for the course will depend on the performance in this exam only; continuous evaluation over the semester will not be taken into consideration. Students will have to achieve the minimum passing grade of 5 and the maximum grade will be capped at 8.0 (out of 10.0) – i.e., “notable” in the in the re-sit exam.

- Re-takers: Students who failed the subject on a previous Academic Year and are now re-enrolled as re-takers in a course will need to check the syllabus of the assigned professor, as well as contact the professor individually, regarding the specific evaluation criteria for them as re-takers in the course during that semester (ordinary call of that Academic Year). The maximum grade that may be obtained in the retake exam (3rd call) is 10.0 (out of 10.0).

- The non-July retakes (this happens in the ordinary period: students in their third attempt) will entail a midterm and a final exam. The weights are as follows: midterm 40%, final 60%. In order to pass, a minimum of 3.5 in the final exam is required.

After ordinary and extraordinary call exams are graded by the professor, you will have a possibility to attend a review session for that exam and course grade. Please be available to attend the session in order to clarify any concerns you might have regarding your exam. Your professor will inform you about the time and place of the review session.
- Students failing more than 18 ECTS credits after the June-July re-sits will be asked to leave the Program. Please, make sure to prepare yourself well for the exams in order to pass your failed subjects.
- In case you decide to skip the opportunity to re-sit for an exam during the June / July extraordinary call, you will need to enroll in that course again for the next Academic Year as a re-taker and pay the corresponding extra cost. As you know, students have a total of 4 allowed calls to pass a given subject or course, in order to remain in the program.

Dates and location of the retakes will be posted in advance and will not be changed. Please take this into consideration when planning your summer.

PROFESSOR BIO

Professor: **BORJA MESA SANCHEZ**

E-mail: bmesa@faculty.ie.edu

Borja Mesa-Sánchez is an expert in the area of industrial organization. After finishing his Ph.D. in Quantitative Economics (with honors) at Universidad de Alicante he joined the Department of Economics of Universidad Carlos III de Madrid as a Post-doctoral fellow. He received a Master Degree in Quantitative Economics, and his Bachelor’s Degree from Universidad Carlos III de Madrid (with honors). His research is in competition policy, game theory and industrial organization. He has published in international scientific journals ranked in JCR by ISI. Borja teaches at undergraduate and graduate level and he has been the advisor for many senior thesis. He has worked in the department of training in Reuters, and he has won two literary awards.

Experience
- Post-doctoral fellow, Universidad Carlos III de Madrid
- Adjunct Professor, Saint Louis University
- Teaching Assistant, Universidad de Alicante
- Training Assistant, Reuters

Education
- Post-doctoral fellow, Universidad Carlos III de Madrid
- Ph.D in Quantitative Economics (with honors), Universidad de Alicante
- Stays in European University Institute and University of York
- MSc in Quantitative Economics, Universidad de Alicante
- Bs Economics (with honors), Universidad Carlos III de Madrid

OTHER INFORMATION

Office hours: Right after the designated classes (upon appointment)

Contact details: bmesa@faculty.ie.edu
CODE OF CONDUCT IN CLASS

1. Be on time: Students arriving more than 5 minutes late will be marked as “Absent”. Only students that notify in advance in writing that they will be late for a specific session may be granted an exception (at the discretion of the professor).

2. If applicable, bring your name card and strictly follow the seating chart. It helps faculty members and fellow students learn your names.

3. Do not leave the room during the lecture: Students are not allowed to leave the room during lectures. If a student leaves the room during lectures, he/she will not be allowed to re-enter and, therefore, will be marked as “Absent”. Only students that notify that they have a special reason to leave the session early will be granted an exception (at the discretion of the professor).

4. Do not engage in side conversation. As a sign of respect toward the person presenting the lecture (the teacher as well as fellow students), side conversations are not allowed. If you have a question, raise your hand and ask it. If you do not want to ask it during the lecture, feel free to approach your teacher after class.

If a student is disrupting the flow of the lecture, he/she will be asked to leave the classroom and, consequently, will be marked as “Absent”.

5. Use your laptop for course-related purposes only. The use of laptops during lectures must be authorized by the professor. The use of Social Media or accessing any type of content not related to the lecture is penalized. The student will be asked to leave the room and, consequently, will be marked as “Absent”.

6. No cellular phones: IE University implements a “Phone-free Classroom” policy and, therefore, the use of phones, tablets, etc. is forbidden inside the classroom. Failing to abide by this rule entails expulsion from the room and will be counted as one absence.

7. Escalation policy: 1/3/5. Items 4, 5, and 6 above entail expulsion from the classroom and the consequent marking of the student as “Absent.” IE University implements an “escalation policy”: The first time a student is asked to leave the room for disciplinary reasons (as per items 4, 5, and 6 above), the student will incur one absence, the second time it will count as three absences, and from the third time onward, any expulsion from the classroom due to disciplinary issues will entail 5 absences.