SVEUČILIŠTE U RIJECI
ODJEL ZA MATEMATIKU

***Sveučilište u Rijeci •Odjel za matematiku***
Radmile Matejčić 2 • 51 000 Rijeka • Hrvatska
T: (051) 584-650 • F: (051) 584-699
*http://www.math.uniri.hr*• e-adresa: math@math.uniri.hr

# COURSE SYLLABUS

| General information | | |
|---|---|---|
| ***Course title*** | Probability Theory | |
| ***Study programme*** | Graduate course Discrete Mathematics and Its Applications | |
| ***Year of study*** | 1st | |
| ***Course status*** | Compulsory | |
| ***Course homepage*** | https://moodle.srce.hr/ | |
| ***Language of instruction*** | English | |
| ***Credit values and modes of instruction*** | ***ECTS credits / student workload*** | 6 |
| | ***Hours (L+E+S)*** | 30+30+0 |
| ***Lecturer*** | ***Name and surname*** | Danijel Krizmanić |
| | ***Office*** | O-312 |
| | ***Office hours*** | Monday, 15:00-16:30 |
| | ***Phone number*** | 584-664 |
| | ***E-mail*** | dkrizmanic@math.uniri.hr |
| ***Teaching assistant*** | ***Name and surname*** | |
| | ***Office*** | |
| | ***Office hours*** | |
| | ***Phone number*** | |
| | ***E-mail*** | |

## 1. COURSE DESCRIPTION

### *1.1. Course objectives*

The main course objective is to get students familiar with basic concepts, methods and results in probability theory. In order to do this, it is necessary within the course to:

- define random variables and analyse their basic properties
- define distribution functions and describe the classification of random variables
- define mathematical expectation and prove limit theorems for mathematical expectation
- define variance and moments of random variables
- prove basic inequalities in probability
- describe basic types of convergence of random variables and their relations
- prove weak and strong laws od large numbers
- describe convergence of series of random variables
- define notion of characteristic function of random variable and analyse basic properties of characteristic functions
- prove inversion and continuity theorems for characteristic functions
- describe weak convergence of sequences of distribution functions
- prove central limit theorem

### *1.2. Course prerequisites*

### *1.3. Learning outcomes*

After completing the course, the students are expected to:

- apply random variables and their properties in solving problems (A7, B7, E4, F5)

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- explain the classification of random variables (A7, B7, E4, F5)
- apply limit theorems for mathematical expectation (A7, B7, E4, F5)
- apply basic probability inequalities (A7, B7, E4, F5)
- explain basic types of convergence of random variables and their relations (A7, B7, E4, F5)
- explain weak and strong laws of large numbers, and convergence of series of random variables (A7, B7, E4, F5)
- apply properties of characteristic functions in solving problems (A7, B7, E4, F5)
- explain inversion and continuity theorems for characteristic functions (A7, B7, E4, F5)
- explain weak convergence of sequence of distribution functions (A7, B7, E4, F5)
- apply the central limit theorem (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

### *1.4. Course content*

Random variables. Distribution functions. Classification of random variables. Mathematical expectation. Limit theorems for mathematical expectation. Variance and moments. Important inequalities in probability. Convergence of random variables. Independence of random variables. Laws of large numbers. Convergence of series of random variables. Characteristic functions. Inversion theorem. Weak convergence. Continuity theorem. Central limit theorem.

| | | |
|---|---|---|
| ***1.5. Modes of instruction*** | ☒ lectures<br>☐ seminars and workshops<br>☒ exercises<br>☒ e-learning<br>☐ field work | ☒ independent work<br>☒ multimedia and the internet<br>☐ laboratory<br>☐ tutorials<br>☐ mentoring work<br>☒ consultative teaching<br>☐ other |
| ***1.6. Comments*** | | |

### *1.7. Student requirements*

Students are required to actively participate in classes. They are required to achieve a certain number of points during the semester and to pass the final exam.

## 2. GRADING POLICY

### *2.1. Grading of students' work during the semester and on the final exam*

Students' work will be evaluated and assessed during the semester and on the final exam. The total number of points a student can achieve during the semester is 50. To approach the final exam, students are required to achieve at least 50% of the total points during the semester, that is, 25 out of 50 points. The maximum number of points that can be achieved on the final exam is 50, while the passing score is 50%. The final exam is an oral and/or written exam.

Students who achieve between 0% and 49.9% through the students evaluation activities will be graded F (Insufficient), they cannot get ECTS credits and will have to enroll the course again. The same is true for students who do not pass the final exam within the three attmepts offered during the examination period.

MIDTERM EXAMS (50 points)
During the semester 2 written midterm exams will be conducted. On each of these exams a student can achieve at most 25 points. If the necessity arises, there will be one make-up midterm exam, in the very end of the semester, on which a student can attempt to achieve a better score, replacing a bad score on only one of the above mentioned midterm exames. If a student decides to use the make-up midterm exam, the grade on the make-up exam will be considered as the final one for that exam, regardless whether it is better or worse than the grade the student was trying to repair.

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FINAL EXAM (50 points)
The final exam is an oral and/or written exam and the maximum number of points that can be achieved is 50. Passing score is 50%.

### *2.2. Minimal requirements for access to the final exam / passing grade*

| ACTIVITY | MINIMAL NUMBER OF POINTS REQUIRED |
|---|---|
| Midterm exams | 25 |
| **TOTAL:** | 25 |
| **OTHER REQUIREMENTS:** | |

### *2.3. Final grade – grading scale*

| GRADE | POINTS |
|---|---|
| Excellent (5) , A | 90% - 100% |
| Very good (4), B | 75% - 89,9% |
| Good (3), C | 60% - 74,9% |
| Sufficient (2), D | 50% - 59,9% |
| Insufficient (1), F | 0% - 49,9% |

## 3. LITERATURE

### *3.1. Required literature*

1. N. Sarapa, Teorija vjerojatnosti, Školska knjiga, Zagreb, 2002.
2. Ž. Pauše, Vjerojatnost – Informacija – Stohastički procesi, Školska knjiga, Zagreb, 2003.

### *3.2. Recommended literature*

1. W. Feller, An Introduction to Probability Theory and Aplication, J.Wiley, New York, 1966.
2. N. Sarapa, Vjerojatnost i statistika, II dio, Školska knjiga, Zagreb, 1996.
3. C. M. Grinstead, J. L. Snell, Introduction to Probablility, American Mathematical Society, 1997. (http://aleph0.clarku.edu/~djoyce/ma217/book-5-17-03.pdf)
4. K. L. Chung, A Course in Probability Theory, Academic Press, 2000.
5. R. Durrett, Probability: theory and examples, Duxbury Press, Belmont, 1996.
6. A. Gut, Probability: A Graduate Course, Springer-Verlag, New York, 2013.

## 4. ADDITIONAL INFORMATION

### *4.1. Class attendance*

Students are reqired to inform themselves about the lectures they did not attend. It is not tolerated to disturb classes and to use phones during the classes.

### *4.2. Informing students*

All relevant course information will be posted on the course homepage. It is the student's personal responsibility to be regularly informed.

### *4.3. Other relevant information*

Students are expected to have a high degree of independence and responsibility in their work. During the course, active learning will be present.

While performing the tasks specified within the course curriculum, students must represent their own work, and they are not allowed to use someone else's text as their own. Submitting without citation work that incorporates someone else's ideas is considered as stealing intellectual property and can be punished according to the regulations. Students should prepare their work according to the instructions given during the classes.

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### *4.4. Assessment of quality and performance for the course*

Quality of the lectures is assessed in accordance with the regulations of the Department of Mathematics and the University of Rijeka. At the end of the semester, an anonymous survey will be conducted, in which students will evaluate the quality of the lectures. Additionally, the department will conduct the analysis of the examination results.

### *4.5. Examination period*

| | |
|---|---|
| ***Final exam (1st examination period)*** | June 29, 2021 |
| ***Final exam (2nd examination period)*** | July 13, 2021 |
| ***Final exam (3rd examination period)*** | September 13, 2021 |

## 5. COURSE OUTLINE*

| *DATE* | *TIME* | *MODE OF INSTRUCTION* | *TOPIC* | *GROUP* | *LECTURE HALL* |
|---|---|---|---|---|---|
| *1.3.2021.* | *13:15-15:00* | *L* | *Introduction to the Course* | *All* | *O-360* |
| *3.3.2021.* | *10:15-12:00* | *E* | *Collections of Sets* | *All* | *O-355* |
| *8.3.2021.* | *13:15-15:00* | *L* | *Random Variables* | *All* | *O-360* |
| *10.3.2021.* | *10:15-12:00* | *E* | *Measurability* | *All* | *O-355* |
| *15.3.2021.* | *13:15-15:00* | *L* | *Distribution Functions* | *All* | *O-360* |
| *17.3.2021.* | *10:15-12:00* | *E* | *Random variables and Vectors* | *All* | *O-355* |
| *22.3.2021.* | *13:15-15:00* | *L* | *Expectation* | *All* | *O-360* |
| *24.3.2021.* | *10:15-12:00* | *E* | *Distribution Functions I* | *All* | *O-355* |
| *29.3.2021.* | *13:15-15:00* | *L* | *Moments, Mean, Variance* | *All* | *O-360* |
| *31.3.2021.* | *10:15-12:00* | *E* | *Distribution Functions II* | *All* | *O-355* |
| *7.4.2021.* | *10:15-12:00* | *E* | *Functions of Random Variables* | *All* | *O-355* |
| *12.4.2021.* | *13:15-15:00* | *L* | *Independence* | *All* | *O-360* |
| *14.4.2021.* | *10:15-12:00* | *E* | *Functions of Random Vectors* | *All* | *O-355* |
| *19.4.2021.* | *13:15-15:00* | *L* | *Inequalities* | *All* | *O-360* |
| *21.4.2021.* | *10:15-12:00* | | *First Midterm Exam* | *All* | *O-355* |
| *26.4.2021.* | *13:15-15:00* | *L* | *Characteristic Functions* | *All* | *O-360* |
| *28.4.2021.* | *10:15-12:00* | *E* | *Expectation* | *All* | *O-355* |
| *3.5.2021.* | *13:15-15:00* | *L* | *Convergence* | *All* | *O-360* |
| *5.5.2021.* | *10:15-12:00* | *E* | *Characteristic Functions* | *All* | *O-355* |
| *10.5.2021.* | *13:15-15:00* | *L* | *Continuity Theorem* | *All* | *O-360* |

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|---|---|---|---|---|---|
| ***12.5.2021.*** | ***10:15-12:00*** | ***E*** | ***Convergence*** | ***All*** | ***O-355*** |
| ***17.5.2021.*** | ***13:15-15:00*** | ***L*** | ***Laws of Large Numbers I*** | ***All*** | ***O-360*** |
| ***19.5.2021.*** | ***10:15-12:00*** | ***E*** | ***Laws of Large Numners*** | ***All*** | ***O-355*** |
| ***24.5.2021.*** | ***13:15-15:00*** | ***L*** | ***Laws of Large Numbers II*** | ***All*** | ***O-360*** |
| ***26.5.2021.*** | ***10:15-12:00*** | ***E*** | ***Continuity Theorem*** | ***All*** | ***O-355*** |
| ***31.5.2021.*** | ***13:15-15:00*** | ***L*** | ***Convergence of Series*** | ***All*** | ***O-360*** |
| ***2.6.2021.*** | ***10:15-12:00*** | | ***Second Midterm Exam*** | ***All*** | ***O-355*** |
| ***7.6.2021.*** | ***13:15-15:00*** | ***L*** | ***The Central Limit Theorem*** | ***All*** | ***O-360*** |
| ***9.6.2021.*** | ***10:15-12:00*** | | ***Make-up Midterm Exam*** | ***All*** | ***O-355*** |

**Minor changes are possible.*

L – lectures
E – exercises
S – seminars