COURSE DESCRIPTION

Empirical Research Methods for Computer Scientists

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	**Babeş-Bolyai University**
1.2. Faculty	Mathematics and Computer Science
1.3. Doctoral Shool	Mathematics and Computer Science
1.4. Field of study	Computer Science
1.5. Level of study	PhD

2. Course-related data

2.1. Course title	**Empirical Research Methods for Computer Scientists**		Course code	MDE8177
2.2. Course coordinator	Assoc. prof. dr. Vescan Andreea			
2.3. Seminar coordinator	Assoc. prof. dr. Vescan Andreea			
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Optional	2.8. Course type		Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					45
Additional research in the library, on subject-specific electronic platforms, and on-site					50
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					80
Tutoring (professional guidance)					10
Examinations					9
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**194**	
3.8. Total hours per semester				**250**	
3.9. Number of credits				**10**	

4. Prerequisites (where applicable)

4.1. curriculum-related	
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. course-related	Course room with video projector, internet
5.2. seminar/laboratory-related	Seminar room with video projector, internet

6. Subject-specific learning outcomes

Knowledge
1. Knows advanced research methods and techniques, theoretical and experimental. Understands scientific methodology applied to the domain.
2. Knows the standards of scientific documentation. Understands the methods of capitalizing on research results.

3. Know the structure and rigors of international academic writing. Understand the rules of citation and presentation.	
4. Knows the principles of collaboration and interrelationship in teams. Understands the dynamics of interdisciplinary groups.	
5. Knows the concepts of critical thinking and logical reasoning. Understands methods of analyzing and interpreting data.	

Skills
1. Designs and applies sophisticated methods for investigating problems.   Uses data processing and interpretation techniques.
2. Document and synthesize relevant scientific information.   Capitalize on work through articles, conferences, and academic channels.
3. Write articles, reports and presentations with clarity.   Adapt the style to the requirements of international journals and conferences.
4. Works effectively in multidisciplinary research teams.   Collaborates constructively and communicates ideas in the group.
5. Analyze and interpret complex problems.   Formulate logical and reasoned reasoning.

Responsibility and autonomy
1. Makes autonomous decisions regarding the choice and adaptation of methods.   Takes responsibility for the correctness of the procedures applied.
2. Takes responsibility for the accuracy of information.   Works independently in selecting and presenting materials.
3. Takes responsibility for the originality and quality of the work.   Works autonomously in the development and revision of academic materials.
4. Takes responsibility for own contribution.   Works autonomously in coordinating tasks and meeting deadlines.
5. Works autonomously in critically evaluating results.   Takes responsibility for justifying decisions.

7. Contents

7.1. Course	Teaching and learning methods	Remarks[1]

1. Course 1
   Introduction- Course objectives & Assessments
   Intro to philosophy of science
	• Interactive exposure
	• Explanation
	• Conversation
	Didactical demonstration	

2. Research Design: qualitative, quantitative, mixed methods Systematic Literature Review	• Interactive exposure • Explanation • Conversation Didactical demonstration	

3. Doing Research
   Finding good research questions
   Theory building
Evidence and Measurements
	• Interactive exposure
	• Explanation
	• Conversation
	Didactical demonstration	

4. Experiments
   Controlled experiments
   Quasi – experiments
Sampling
	• Interactive exposure
	• Explanation
	• Conversation
	Didactical demonstration	

5. Quantitative analysis
   Basic Stats
   Choosing a statistical model
	• Interactive exposure
	• Explanation
	• Conversation	

[1] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Statistical Power Analysis	Didactical demonstration	
6. Qualitative analysis Grounded theory Coding strategies Phenomenography	• Interactive exposure • Explanation • Conversation Didactical demonstration	
7. Interviews and Observation Conducting Interviews Focus Group Participant Observation	• Interactive exposure • Explanation • Conversation Didactical demonstration	
8. Case studies Single and multi-case Longitudinal Case studies	• Interactive exposure • Explanation • Conversation Didactical demonstration	
9. Survey Research Designing questionnaires Sample size	• Interactive exposure • Explanation • Conversation Didactical demonstration	
10. Intervention methods Action Research Pilot Studies	• Interactive exposure • Explanation • Conversation Didactical demonstration	
11. Replication Importance of replications Bias and influences Threats to validity	• Interactive exposure • Explanation • Conversation Didactical demonstration	
12. Publishing and reviewing	• Interactive exposure • Explanation • Conversation Didactical demonstration	
13. Projects by students (1) Workshop Peer review (anonymous+live)	• Interactive exposure • Explanation • Conversation Didactical demonstration	
14. Projects by students (2) Workshop Reflection/Debriefing Lessons learned	• Interactive exposure • Explanation • Conversation Didactical demonstration	

Bibliography

Books:
[1] Forrest ShullJanice SingerDag I. K. Sjøberg, Guide to Advanced Empirical Software Engineering, Springer, 2008
[2] Seltman, Experimental Design and Analysis, 2018
[3] Michael Felderer, Guilherme Horta Travassos, Contemporary Empirical Methods in Software Engineering, Springer, 2020
[4] Cohen, P. (1995). Empirical Methods in Artificial Intelligence. MIT Press.
[5] James, Witten, Hastie and Tibshirani, An Introduction to Statistical Learning, with Applications in R

Articles
[1] Fagerholm F, Kuhrmann M, Münch J., Guidelines for using empirical studies in software engineering education, PeerJ Computer Science 3:e131, 2017

[2] Barbara Kitchenham, O. Pearl Brereton, David Budgen, Mark Turner, John Bailey, Stephen Linkman, Systematic literature reviews in software engineering – A systematic literature review, Information and Software Technology, Volume 51, Issue 1, 2009, Pages 7-15, ISSN 0950-5849,

[3] Arcuri A, Briand L (2011) A practical guide for using statistical tests to assess randomized algorithms in software engineering. In: International conference on software engineering, pp 1–10

[4] Carver JC (2010) Towards reporting guidelines for experimental replications: a proposal. In: The international workshop on replication in empirical software engineering, pp 2–5

[5] Carver JC, Juristo N, Baldassarre MT, Vegas S (2014) Replications of software engineering experiments. Empir Softw Eng 19(2):267–276

[6] Gomez OS, Juristo N, Vegas S (2014) Understanding replication of experiments in software engineering: a ´ classification. Inform Softw Technol 56(8):1033–1048.

[7] Shepperd M, Ajienka N, Counsell S (2018) The role and value of replication in empirical software engineering results. Inf Softw Technol 99:120–132

[8] Fagerholm F, Becker C, Chatzigeorgiou A, Betz S, Duboc L, Penzenstadler B, Mohanani R, Venters CC (2019) Temporal discounting in software engineering: a replication study. In: 13Th ACM/IEEE international symposium on empirical software engineering and measurement, IEEE, pp 1–12.

The course exists in the studying program of all major universities in Romania and abroad;
The course „Applications of Data Science for Software Engineering" at Eindhoven University of Technology
The course „Empirical Methods" at Carnegie Mellon University
The course „Empirical Software Engineering: Bridging Research and Practice" at University of Victoria
The course „Empirical Research Methods for Computer Scientists" at University of Toronto.

7.2. Seminar/ laboratory	Teaching and learning methods	Remarks
1. Literature review. Theory.	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
2. Research questions	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
3. Comparison of methods	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
4. Experiments	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
5. Quantitative analysis	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
6. Qualitative analysis (1)	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	

7. Qualitative analysis (2)	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	

Bibliography

The bibliography for the lectures.
For each seminar, a set of 2-3 papers will be provided in advance to be read and discussed during the seminars.

8. Evaluation

Type of activity	8.1 Evaluation criteria[2]	8.2 Evaluation methods[3]	8.3 Percentage in the final grade
8.1. Course	- be able to implement course concepts - apply techniques for different classes of research investigations	Project -documentation -design -continous observations	50%
8.2. Seminar/ laboratory	- know the concepts discussed during the lectures and applied during seminars	Assignments	40%
	- class participation and in-class presentations	Class participation	10%
8.3 Minimum standard for passing			

- Seminar/Laboratory assignments work may not be redone in the retake session.
- Project-based exam can be taken during the retake session.
- Students from Previous Years to the current academic year
- All the above rules apply to students from previous years.
- Seminar/Laboratory assignments must be redone during didactic activity time (in the 14 weeks before normal session).
- At least grade 5 (from a scale of 1 to 10) at written exam. The final grade computed with the given formula must be at least 5 in order to pass the exam. At least grade 5 (from a scale of 1 to 10) at project-based exams and laboratory/seminar activity

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[2] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[3] Both final evaluation methods and ongoing evaluation strategies should be established.

9. SDG labels (Sustainable Development Goals)[4]

SDG wheel logo	○	Sustainable Development Generic Label

1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO"	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	○	○	○	○	○	○

10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
12 February 2026

Signature of course coordinator

Assoc. Prof. Habil. Vescan Andreea, PhD

Signature of seminar coordinator

Assoc. Prof. Habil. Vescan Andreea, PhD

Date of approval in the department:

Signature of the head of department

Assoc. Prof. Sterca Adrian, PhD

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[4] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*