SYLLABUS

Formal Languages and Compiler Design

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş Bolyai University
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Department of Computer Science
1.4. Field of study	Mathematics
1.5. Study cycle	Bachelor
1.6. Study programme/Qualification	Mathematics and Computer Science
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the dis	scipli	ne Formal L	Formal Languages and Compiler Design				n Discipline code	MLE5023
2.2. Course coordinator				Prof.	Phl	D. Simona Motogna		
2.3. Seminar coordinator					Prof.	Phl	D. Simona Motogna	
2.4. Year of study	3	2.5. Semester	Semester 5 2.6. Type of evaluation				2.7. Discipline regime	Mandatory

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	6	of which: 3.2 course	2	3.3 seminar/laboratory/project	1 sem + 1 lab
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory/project	28
Time allotment for individual study (ID) and self-study activities (SA)					hours
Learning using manual, course support, bibliography, course notes (SA)				7	
Additional documentation (in libraries, on electronic platforms, field documentation)					4
Preparation for seminars/labs, homework, papers, portfolios and essays					6
Tutorship					1
Evaluations					1
Other activities:					-
3.7. Total individual study hours19					
3.8. Total hours per semester	75				
3.9. Number of ECTS credits	3				

4. Prerequisites (if necessary)

4.1. curriculum	Data Structures and Algorithms
4.2. competencies	Average programming skills in a high level programming language

5. Conditions (if necessary)

5.1. for the course	Course room with projector
5.2. for the seminar /lab activities	Laboratory with computers; high level programming language environment (.NET
	of any Java/Python environment a.s.o.j

6.1. Specific competencies acquired ¹

¹ One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	 advanced programming skills in high-level programming languages use of theoretical foundations of computer science as well as of formal models
Transversal competencies	 application of organized and efficient work rules, of responsible attitudes towards the didactic-scientific field, to bring creative value to own potential, with respect for professional ethics principles and norms use of efficient methods and techniques to learn, inform, research and develop the abilities to bring value to knowledge, to adapt at the requirements of a dynamical society and to communicate efficiently in Romanian language and in an international language

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Be able to understand compiler design and to implement compiler techniquesImproved programming skills
7.2 Specific objective of the discipline	 Acquire knowledge about back-end of a compiler Understand and work with formal languages concepts: Chomsky hierarchy; regula automata and the equivalence between them; context-free grammars, push-dow their equivalence Understand and work with compilers concepts: scanning, parsing

8. Content

8.1 Course	Teaching methods	Remarks
1. General Structure of a compiler. Compiler phases	Exposure: description, explanation, examples, discussion of case studies	
2. Scanning (Lexical Analysis)	Exposure: description, explanation, examples, discussion of case studies	
3. Introductory notions of formal languages. Grammars and Finite Automata	Exposure: description, explanation, examples, debate, dialogue	
4. Regular languages, regular expressions, equivalence between finite automata, regular grammars and regular expressions. Pumping lemma	Exposure: description, explanation, examples, proofs	
5. Context-free grammars, syntax tree	Exposure: description, explanation, examples, discussion of case studies	
6. Parsing: general notions, classification.	Exposure: description, explanation, examples, discussion of case studies	
7. Recursive-descendant parser	Exposure: description, explanation, examples, discussion of case studies	

8. LL(1) parser	Exposure: description, explanation, examples, discussion	
	of case studies	
	Exposure: description,	
9. LR(k) parsing method. LR(0) parser	explanation, examples, discussion	
	of case studies	
10 CLD LD(1) LALD memory	Exposure: description,	
10. SLR, LR(1), LALR parser	explanation, examples, discussion	
	Fynosure: description examples	
11. Scanner generator (lex); Parser generators	discussion of case studies, live	
(yacc)	demo	
12 Attribute grammane concretion of	Exposure: description,	
12. Attribute granniars; generation of	explanation, examples, discussion	
	of case studies	
13 Code optimization and object code	Exposure: description,	
generation	explanation, examples, discussion	
	of case studies	
14 Duch down outomate and Turing machines	Exposure: description,	
14. Push-down automata and Turing machines	explanation, examples, discussion	
Bibliography	of case studies	
1 A V AHO D I III.LMAN - Principles of compute	er design Addison-Wesley 1978	
2. A.V. AHO, D.J. ULLMAN - The theory of parsing	translation and compiling. Prentice-	Hall, Engl. Cliffs., N.I., 1972, 1973.
3. D. GRIES - Compiler construction for digital co	mputers,, John Wiley, New York, 197	1.
4. MOTOGNA, S. – Metode de proiectare a compil	atoarelor, Ed. Albastra, 2006	
5. SIPSER, M., Introduction to the theory of comp	utation, PWS Pulb. Co., 1997	
6. CSÖRNYEI ZOLTÁN, Bevezetés a fordítóprogra	amok elméletébe, I, II., ELTE, Budapes	st, 1996
7. L.D. SERBANATI - Limbaje de programare si co	ompilatoare, Ed. Academiei RSR, 1983	7.
8. CSÖRNYEI ZOLTÁN, Fordítási algoritmusok, E	rdélyi Tankönyvtanács, Kolozsvár, 20	000.
9 DEMETROVICS JANOS-DENEV I -PAVLOV R	A számítástudomány matematikai ala	niai Nemzeti Tankönyykiadó
	i ozanintaotta aonianj inatorna tina an	ipjai, weinzeer rankony vkiado,
Budapest, 1999	IDOEN K. Modern Compiler Design	John Wiley, 2000
Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN	IDOEN, K.: Modern Compiler Design,	John Wiley, 2000
Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory	IDOEN, K.: Modern Compiler Design, Teaching methods	John Wiley, 2000 Remarks
Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies	John Wiley, 2000 Remarks
Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies	John Wiley, 2000 Remarks
Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies,	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies,	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies,	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 	 IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof 	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers 	 IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof 	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language specification (BNF 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language specification (BNF notation) 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language specification (BNF notation) Task 1: Specify a mini-language and implement 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata – regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language and implement scanner 1.2: Writing a small program in the 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language and implement scanner 1.2: Writing a small program in the minilanguage 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language and implement scanner 1.2: Writing a small program in the minilanguage Task 1: Specify a mini-language and implement scanner 1.2: Writing a small program in the minilanguage 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies Explanation, dialogue, case studies Testing data discussion,	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language and implement scanner 1.2: Writing a small program in the minilanguage Task 1: Specify a mini-language and implement scanner 1.3: Use lex for scanner 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies Explanation, dialogue, case studies Testing data discussion, evaluation	John Wiley, 2000 Remarks
 Budapest, 1999 10. GRUNE, DICK - BAL, H JACOBS, C LANGEN 8.2 Seminar / laboratory 1. Specification of a programming language; BNF 2. Grammars; language generated by a grammar; grammar corresponding to a language 3. Finite automata: language generated by a FA; FA corresponding to a language 4. Transformations: finite automata - regular grammars 5. Context free grammars; descendent recursive parser 6. LL(1) parser 7. LR(0) parsers Laboratory Task 1: Specify a mini-language and implement scanner 1.1: Mini language and implement scanner 1.2: Writing a small program in the minilanguage Task 1: Specify a mini-language and implement scanner 1.3: Use lex for scanner Task 1: Specify a mini-language and implement scanner 1.3: Use lex for scanner 	IDOEN, K.: Modern Compiler Design, Teaching methods Explanation, dialogue, case studies Dialogue, debate, case studies, examples, proof Explanation, dialogue, case studies Explanation, dialogue, case studies Testing data discussion, evaluation Explanation, dialogue, case	John Wiley, 2000 Remarks

Task 2: Parsing 2.1: Define grammar for specified syntactical structures	Explanation, dialogue, case studies			
Task 2: Parsing	Testing data discussion,			
2.2: Use yacc for parsing	evaluation			
Task 3: Parsing	Testing data discussion,			
3.1: Final delivery	evaluation			
Bibliography:				
1. A.V. AHO, D.J. ULLMAN - Principles of computer design, Addison-Wesley, 1978.				
2. A.V. AHO, D.J. ULLMAN - The theory of parsing, translation and compiling, Prentice-Hall, Engl. Cliffs., N.J., 1972, 1973.				
3. MOTOGNA, S. – Metode de proiectare a compilatoarelor, Ed. Albastra, 2006				
4. G. MOLDOVAN, V. CIOBAN, M. LUPEA - Limbaje	e formale si automate. Culegere de pr	obleme, Univ. Babes-Bolyai, Cluj-		

Napoca, 1996.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course respects the IEEE and ACM Curriculla Recommendations for Computer Science studies;
- The course exists in the studying program of all major universities in Romania and abroad;
- The content of the course is considered the software companies as important for average programming skills

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade		
	- know the basic principle of	Written exam	60%		
10.4 Course	the domain; - apply the course concepts				
	- problem solving				
	- be able to apply algorithms, understand examples - problem solving	problems solved - homeworks delivered - continuous observations during semester	10%		
10.5 Seminar/laboratory	 be able to implement course concepts and algorithms apply techniques for different classes of programming languages 	-Practical examination duri documentation -portofolio -continuous observations	30%		
10.6 Minimum standard of performance					
Attend 75% of seminar activities during semester AND attend 90% of lab activities during semester					

• At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work.

• Understand basic concepts of formal languages: grammars, finite automata; be able to apply scanning and parsing algorithms

11. Labels ODD (Sustainable Development Goals)²

Not applicable.

Date:

12.04.2025

Signature of course coordinator

Signature of seminar coordinator

Prof.PhD. Simona Motogna

Prof.PhD. Simona Motogna

² Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write *"Not applicable."*.

Date of approval:

....

Signature of the head of department

Assoc.prof.phd. Adrian STERCA