SYLLABUS / FIŞA DISCIPLINEI

1. Information on the study programme / Date despre programul de studii

1.1. Institution / Instituţia de învăţământ superior	Universitatea de Vest din Timişoara
1.2. Faculty / Facultatea	Matematică şi Informatică
1.3. Department / Departamentul	Computer Science (Informatică)
1.4. Study program field	Computer Science (Informatică)
1.5. Study cycle/ Ciclul de studii	Bachelor / licenţă
1.6. Study programme / Programul de studii / calificarea*	Computer Science / Informatică în limba engleză / Database administration / *Administrator baze de date - 252101; Computer network administration / Administrator de retea de calculatoare - 252301; Analyst / Analist - 251201; Research assistant in computer science / Asistent de cercetare în informatica - 214918; Teacher in secondary schools / Profesor în învatamântul gimnazial - 233002; Programmer / Programator - 251202; Software systems designers / Proiectant sisteme informatice - 251101*

2. Information on the course / Date despre disciplină

2.1. Title of the course / Denumirea disciplinei	Formal Methods in Software Development						
2.2. Teacher in charge of the course / Titularul activităţilor de curs	Madalina Erascu						
2.3. Teacher in charge of the seminar / Titularul activităţilor de seminar	Madalina Erascu						
2.4. Study year / Anul de studii	2	2.5. Semester / Semestrul	1	2.6. Examination type / Tipul de evaluare: /C(olloquim)	C	2.7. Course type / Regimul disciplinei: E(lective)	D O

3. Estimated study time (number of hours per semester) /Timpul total estimat (ore pe semestru al activităţilor didactice)

3.1. Attendance hours per week / Număr de ore pe săptămână	3	out of which din care: 3.2 lecture/ curs	2	3.3. seminar/laborator	1
3.4. Attendance hours per semester / Total ore din planul de învăţământ	42	out of which: 3.5 lecture / curs	28	3.6. seminar/laborator	14
Distribution of the allocated amount of time / Distribuţia fondului de timp*					**hours / ore**
Individual study /Studiu după manual, suport de curs, bibliografie şi notiţe					30
Supplementary documentation at library or using electronic repositories / Documentare suplimentară în bibliotecă, pe platformele electronice de specialitate					10

Preparing for laboratories, homework, reports etc. /Pregătire seminarii/laboratoare, teme, referate, portofolii şi eseuri	20
Exams / Examinări	2
Tutoring / Tutorat	2

3.7. Total number of hours of individual study / Total ore studiu individual	130
3.8. Total number of hours per semester / Total ore pe semestru	60
3.9. Number of credits (ECTS) / Număr de credite	5

4. Prerequisites (if it is the case) / Precondiţii (acolo unde e cazul)

4.1. curriculum / de curriculum	Computational logic, algorithmics
4.2. skills / de competenţe	Mathematical knowledge and problem solving skills

5. Requirements (if it is the case) / Condiţii (acolo unde e cazul)

5.1. for the lecture / de desfăşurare a cursului	Classroom with blackboard and video projector
5.2. for the seminar, laboratory / de desfăşurare a seminarului/laboratorului	Classroom with blackboard, video projector and computers. If needed, we will install a virtual machine with the needed software.

6. Acquired skills / Competenţe specifice acumulate

Professional skills / Competenţe profesionale	Presentation and understanding of (1) the importance of logical theories in the verification of programs, with (2) application to use-cases using emerging technologies (IoT, AI).
Transversal skills / Competenţe transversale	The ability of communicating knowledge about the usage of logical methods for different problems (optimization, verification of certain program properties, etc.)

7. Objectives of the course / Obiectivele disciplinei (reieşind din grila competenţelor specifice acumulate)

7.1. General objective / Obiectivul general al disciplinei	Understanding how logical methods are useful for verifying different properties of software.
7.2. Specific objectives / Obiectivele specifice	*Knowledge objectives:* understanding and usage propositional and predicate logic in program analysis and verification (optimization, loop invariants, termination terms, program specification).

	Abilitation objectives: basic and advanced usage of dedicated software SAT solvers, SMT solvers, Mathematica. *Atitudinal objectives*: motivation and argumentation of the importance of logical methods in modelling, verifying and optimizing the software.

8. Content / Conţinuturi*

8.1. Lecture / Curs	Teaching strategies / Metode de predare	Remarks, details / Observaţii
C1-2 (4h). *Organizational matters and course motivation. Motivating example: verification of deep neural networks (crash presentation on neural networks, verification problem description and formalization, challenges, solutions, limitations)*	Lecture, conversation, illustration	References: ● M. Erascu slides
C3-C4 (*4h*). *Propositional logic. SAT solving. DPLL and CDCL algorithms*	Same as above	Same as above
C5-6 (*2h*). SAT@Work: Formalization of scheduling problems with propositional logic; DIMACS format. SAT solvers	Same as above	Same as above
C7 (*2h*). *First-Order Theories. Decidability*	Same as above	Same as above
C8 (*2h*). *Midterm*		
C9 (*2h*). *Principles of SMT solving. SMT-LIB format*	Same as above	Same as above
C10 (*2h*). *Linear real arithmetic.Fourier Motzkin algorithm. Examples.*	Same as above	Same as above
C11 (*2h*). *Linear integer arithmetic: Branch and bound algorithm, Examples.*	Same as above	Same as above
C12-13 (2h). Presentation of students projects	Same as above	Same as above
C14 (2h). Examination	Same as above	Same as above

Recommended bibliography / Bibliografie
[1] C.-L. Chang, R. C. T. Lee. *Symbolic Logic and Mechanical Theorem Proving*. Computer Science Classics
[4] L. de Moura, N. Bjorner. *Satisfiability Modulo Theories: Introduction and Applications.*
[5] J. Woodcock et al. *Formal Methods: Practice and Experience*
[6] Formal Verification of Object-Oriented Software: http://www.cost-ic0701.org/
[7] A. Biere, M. Heule, H. Van Maaren, T. Walsh. *Handbook of Satisfiability*. IOS Press 2009
[8] A. Bradley, Z. Manna. The Calculus of Computation. Decision procedures with Applications to Verification. Springer 2007
[9] D. Kroening, O. Strichman. *Decision Procedures An Algorithmic Point of View*. Springer 2008
[10] J.-C. Régin and M. Rezgui. *Discussion about Constraint Programming Bin Packing Models*. AI for Data Center Management and Cloud Computing: Papers from the 2011 AAAI Workshop (WS-11-08)
[11] Edited by Francesca Rossi, Peter van Beek, Toby Walsh. Handbook of Constraint Programming, 2006, Elsevier. In particular Chapter 10.
[12] E. Abraham. SAT-checking. Lecture Notes, RWTH Aachen, https://ths.rwth-aachen.de/teaching/ws14/lecture-sat-checking/

8.2. Seminar, lab / Seminar, laborator	Teaching/learning strategies / Metode de predare/ invăţare	Remarks, details / Observaţii
L1-7 (*2h*). *Exercises on the topics presented as well as formalization of problems and application of SAT/SMT solvers for different practical problems.*	Questioning, dialogue, collaborative learning	The labs will be available on the website before the lecture and students have to work on those subjects during the lab.

Recommended bibliography / Bibliografie
- same as for the lecture
- SAT solvers
- Z3 SMT solver (https://github.com/Z3Prover/z3), OptiMathSAT (http://optimathsat.disi.unitn.it)

9. Correlations between the content of the course and the requirements of the IT field / Coroborarea conţinuturilor disciplinei cu aşteptările reprezentanţilor comunităţii epistemice, asociaţiilor profesionale şi angajatorilor reprezentativi din domeniul aferent programului

The content of the lecture is similar to others, on the same topic, from other universities. It covers the fundamental notions for understanding why formal methods for software development are so important. Currently, the lecture seems to be not that useful for ordinary IT companies in Romania. However, formal methods are necessary for safety-critical systems (avionics, cars, medical devices) becoming mandatory. We foresee a need of them in the next decade in Romania, too.

10. Evaluation / Evaluare*

Universitatea de Vest din Timişoara

MINISTERUL EDUCAŢIEI NAŢIONALE ŞI CERCETĂRII STIINTIFICE – UNIVERSITATEA DE VEST DIN TIMIŞOARA
CENTRUL DE DEZVOLTARE ACADEMICĂ

Activity / Tip de activitate	10.1. Evaluation criteria / Criterii de evaluare**	10.2. Evaluation methods / Metode de evaluare***	10.3. Weight in the averaged mark / Pondere din nota finală
10.4. Lecture / Curs	Knowledge and application of notions from C1 - C7.	Midterm	30%
	Knowledge and application of notions from C9 - C11.	Written exam in the last lecture (Course 14)	20%
10.5. Laboratory	- The ability to learn and apply concepts presented during the lectures - The ability to reproduce research results with instructor advice/help - The ability to deliver the reproduced results in a presentation and demo	Activity during the labs; presentation during lectures C12-13	60%

10.6. Minimal knowledge for passing / Standard minim de performanţă

Minimal knowledge for passing (grade 5): acquiring fundamental understanding of the knowledge of propositional logic, first order logic, program analysis and verification.

The final grade is computed as a weighted average of the grades given for the components specified in 10.4- 10.6, however it does not have negative impact on the grade if this activity is not fulfilled. The exam is passed if the average is equal or greater than 4.1 (not necessary that each grade to be greater than 4.1). The start at Midterm and Final Exam is 0. If the final grade is greater than equal to 4.1 means 5, greater than equal to 5.1 means 6, …, greater than equal to 9.1 means 10.

At each exam sessions (including reexamination and improvements), the score is computed by the same rule. Midterm can not be retaken.

There is no mandatory presence requirement, however, note that your lab grade is based on your activity during the semester (you will be graded at the end of each lab).

Note: Students may attend office hours (2 modules / week according to the schedule set out at the beginning of the semester) where the lecturer (course/seminar) answers questions students and provides further explanations related to course content, applications from seminary themes.

Date/ Data completării	Signature (lecture) / Semnătura titularului de curs	Signature (seminar) Semnătura titularului de seminar
19.08.2018	Madalina Erascu	Madalina Erascu

Signature (director of the department)
Semnătura directorului de departament
Conf.dr. Victoria Iordan