Valid for academic year: 2019- 2020

COURSE DESCRIPTION

1. Program details

University	“Lucian Blaga” University of Sibiu
Faculty	Engineering Faculty
Department	Department of Computer Science and Electrical and Electronics Engineering
Main field of study	Computer Engineering and Information Technology
Level of education	Master
Specialization	Advanced Computing Systems

2. Course details

Course title	Metode de cercetare în arhitecturile de calcul avansate / Research Methods in Advanced Computing Architectures			
Course code	Type of course	Year of study	Semester	Number of credits
mACS.101.SO	SD	1	1	9
Evaluation type	Type of course (FD=fundamental discipline.; DD=domain discipline; SD=specialized discipline; CD=complementary discipline)			
Exam	SD			
Course instructor	Prof. Lucian Vintan, PhD			
Seminar/lab/project instructor	Assoc. Prof. Arpad Gellert, PhD			

3. Estimated time

Course duration in the curriculum – number of hours per week				
Lecture	Seminar	Lab	Project	Total
3	-	2	-	**5**
Course duration in the curriculum - Total of hours curriculum				
Lecture	Seminar	Lab	Project	Total (*$NOAD_{sem}$*)
42	-	28	-	**70**

Distribution of hours for individual study	No. hours
Individual study using course handbooks, bibliography and notes	100
Additional documentation in library and on specialized electronic platforms	10
Preparing seminars / labs, homework, essays and portfolios	100
Tutoring	10
Exam preparation	10
Total hours for individual study ($NOSI_{sem}$)	70
Total hours per semester ($NOAD_{sem}$ + $NOSI_{sem}$)	**140**

4. Prerequisites (if applicable)

curriculum	Knowledge in Computer Architecture
competencies	C/C++ and Java Programming skills

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Universitatea "Lucian Blaga" din Sibiu

"Lucian Blaga" University of Sibiu
Faculty of Engineering
Department of Computer Science and
Electrical and Electronics Engineering

5. Conditions (if applicable)

course materials	Study the recommended scientific papers; Video-projector, Blackboard
sem/lab/project materials	Lab Room with computers having installed the necessary software tools (see the applications)

6. Specific competences acquired

Professional competence	Research and Development Competences in Computer Engineering Field
Transversal competences	Project Management, Research Management, Team Working, Domain Research (Scientific) Axiology

7. Objectives (based on the specific grid for the accumulated competences)

General objective	Introducing in Computer Architecture Research
Specific objectives	• Understanding what is research in Advanced Computer Architecture (Modelling, Trace-Driven & Execution-Driven Simulation, Benchmarking, Iterative Optimization, Automatic Design Space Exploration, Writing Papers, etc.) • Understanding some research papers, technical reports, PhD Theses, etc. in Advanced Computing Architectures domain. Understanding the multicore and manycore research paradigm. • Developing a research project and writing a scientific paper based on it

8. Contents

Course		No. hours
Course 1	1. Introduction to prediction and speculative execution implemented in Computer Architectures	3 hours
Course 2	2. Advanced Branch Prediction Methods 2.1 Dynamic Neural Branch Prediction. Genesis 2.1.1 Previous Work in the Field 2.1.2 First Neural Dynamic Branch Prediction Models 2.2 Trace Driven Simulation Results 2.3 A Static Branch Neural Predictor 2.4 Some Comments to Neural Branch Prediction Idea 2.5 Making it feasible: Perceptron Branch Predictors **2.6 Towards cross-fertilization between computer architecture and other computer science fields** 2.6.1 Some oher Neural Approaches in Computer Arhitecture 2.6.2 A Markovian Branch Predictor 2.6.3 Genetic Branch Predictors	3 hours
Course 3	3. Understanding Some Present-Day Branch Prediction Limits 3.1 Unbiased Branches Problem and Related Works 3.2 Finding Unbiased Branches. Research Methodology	3 hours

	3.3 Some Experimental Results (Simulation) 3.4 Some Conclusions and Further Work	
Course 4	**4. Pre-Computing Branches (PCB)** 4.1 Introduction 4.2 The Pre-Computed Branch Algorithm 4.3 Complexity and Costs Evaluations 4.4 Performance Evaluations through Simulation 4.5 Some Conclusions and Further Work 4.6 Appendix. PCB Algorithm	3 hours
Course 5	5. Dynamic Instruction Reuse 5.1 Fetch Bottleneck. Dynamic instruction reuse through trace-cache processors 5.2 Issue (Data- Flow) Bottleneck. Dynamic Instruction Reuse. Function Reuse	3 hours
Course 6	6. Dynamic Instruction Value Prediction and Speculation 6.1 Introduction to Value Prediction 6.2 Predicting Load Instructions 6.3 Generalised Value Prediction **6.3.1 Computational Predictors** 6.3.2 Contextual Predictors 6.3.3 Hybrid predictors 6.4 The Value Prediction Speedup. A Simple Analytical Model	3 hours
Course 7	7. Focalizing Dynamic Value Prediction to CPU's Registers ***7.1 The Register Value Predictor Concept*** 7.2 Register Value Predictors 7.3 Simulation Methodology and Experimental Results 7.4 Register Value Prediction using Meta-predictors 7.5 Meta-predictors' Simulations and Quantitative Evaluations 7.6 Conclusions and some Further Work Ideas	3 hours
Course 8	**8. Neural Networks Models with Applications in Ubiquitous Computing. Next Location Prediction** 8.1 Introduction to *UbiCom* 8.2 A Related Concept: Autonomic Computing 8.3 The Next Location Prediction Problem in an *UbiCom* Environment ***8.4 Person Movement Prediction Using Neural Networks*** 8.5 Experimental Results. Analysis and Comments 8.6 Some Conclusions and Further Work Ideas	3 hours
Course 9	**9. Hidden Markov Models with Applications in Ubiquitous Systems. Next Location Prediction** 9.1 Applications based on Hidden Markov Models	3

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	9.2 Discrete Markov Processes **9.3 Hidden Markov Models of order 1** **9.4 Prediction algorithm using a HMM of order 1**	
Course 10	***9.5 A possible generalization: Hidden Markov Models of order R>1*** **9.6 Prediction algorithm using a HMM of order R>1** 9.7 Methodology and Experimental Results 9.8 Some Conclusions	3
Course 11	**10. Multiprocessor systems on chips (MPSOCS).** Why MPSOCS? Challenges, design methodologies, hardware architectures, software, Performance modeling and analysis. Design of communication architectures for MPSOCS.	3
Course 12	**10. Multiprocessor systems on chips (MPSOCS).** Memory systems and compiler support for MPSOCS. Component-based design. Models of computation for MPSOCS.	
Course 13	**10. Multiprocessor systems on chips (MPSOCS).** Multicores based on speculative-execution processors. Automatic Design Space Exploration (heuristic algorithms, complex tool implementation).	3
Course 14	**10. Multiprocessor systems on chips (MPSOCS).** Network on a Chip simulator and optimal tasks mapping for a parallel software application	3
	Total course hours:	42
Laboratory		No. hours
Lab 1	Next Location (Context) Prediction in an intelligent *UbiCom* ambient (Augsburg benchmarks belonging to the Smart_Doorplates project - we have the benchmarks through an institutional collaboration) A Neural Approach. A Markov Approach. A Hidden Markov Models Approach.	2
Lab 2	Integrating Dynamic Instruction Reuse (DIR) in an advanced superscalar/SMT microarchitecture Simulations on SPEC 2000 benchmarks	2
Lab 3	Integrating Dynamic Value Prediction (DVP) in an advanced superscalar/SMT microarchitecture Simulations on SPEC 2000 benchmarks	2
Lab 4	Focalising Dynamic Value Prediction to CPU's Context. Simulations on SPEC 2000 benchmarks	2
Lab 5	Developing an Adaptive Meta-Predictor for a Hybrid Dynamic Value Predictor (multiple DVPs). Simulations on SPEC 2000 benchmarks	2
Lab 6	Integrating Advanced Hybrid Branch Predictors (Two Level Adaptive + Neural, Perceptron) in an advanced superscalar microarchitecture. Simulations on SPEC 2000 and INTEL CBP benchmarks	2
Lab 7	Understanding and Predicting Indirect Branch Behavior. Simulations on SPEC 2000 benchmarks and some developed specific C/C++ programs	2
Lab 8	Detecting and Predicting Unbiased Branches. Simulations on SPEC 2000 and INTEL CBP benchmarks	2
Lab 9	Solving Fetch Bottleneck. Trace-Processor Simulation (SPEC 2000)	2

Lab 10	Investigating Procedural/Object Programming Corpus' Influence on DIR/DVP	2
Lab 11	Simulating Multicore Architectures. Full system simulation (SNIPER)	2
Lab 12	Automatic Design Space Exploration in Multicore Systems. Multi-objective Optimization Methods (PARETO)	2
Lab 13	Network on a Chip simulator and optimal tasks mapping for a parallel software application	2
Lab 14	Parallel Programming. Optimal mapping on heterogeneous multicore systems(accelerating some Computational Fluid Dynamics Programs)	2
	Total lab hours:	28

Teaching methods

Proofs, Simulations, Analyses, Discussions, Presentations	Language of instruction	English

References

Recommended reading	**VINŢAN N. LUCIAN** – ***Prediction Techniques in Advanced Computing Architectures*** (în limba engleza), **Matrix Rom Publishing House, Bucharest**, ISBN 978-973-755-137-5, 2007 (292 pg.); 3 ex. ULBS + 7 schimb interbibliotecar; cota Biblioteca ULBS 52.103; a se vedea: http://www.matrixrom.ro/romanian/editura/domenii/informatica.php?id=867#867
	GELLERT A., **VINŢAN L. N.**, FLOREA A. - ***A Systematic Approach to Predict Unbiased Branches***, ISBN 978-973-739-516-0, **"Lucian Blaga" University Press, Sibiu**, 2007 (111 pg.); 8 ex. Bibl. ULBS + 10 schimb interbibliotecar; cota Biblioteca ULBS 53.048
	Papers recommended at http://webspace.ulbsibiu.ro/lucian.vintan/html/Cheia_SPPD.doc
	Papers from http://webspace.ulbsibiu.ro/lucian.vintan/html/#10
	VINŢAN N. LUCIAN – ***Fundamente ale arhitecturii microprocesoarelor*****, Editura Matrix Rom, Bucureşti**, ISBN 978-606-25-0276-8, 2016 (547 pg.), v. http://www.matrixrom.ro/romanian/editura/domenii/cuprins.php?cuprins=FA50; 2 exemplare la Biblioteca ULBS, cota 04/V64 + 5 schimb inter-bibliotecar
More references	**VINȚAN L. N.,** *Pilule pentru oameni vii,* Matrix Rom, București, ISBN 978-606-25-0088-7, 2014 (97 pg.); 2 ex. Bibl. ULBS cota 37/V64

9. Linking course content with expectations of the epistemic community representatives, professional associations and employers' representatives in the field related to the program

Curricula are continuously updated based on the most prestigious international text-books and also based on the most relevant progresses in this field (as these developments are presented in top-level scientific reviews, research projects and international conferences).

10. Evaluation

Type	Evaluation criteria	Evaluation methods	Percentage in final grade	Obs.*
Course	Assesments	Writing Work	10%	CPE
	Exam	Writing Exam	60%	CEF
Lab	Scientific Reports	Presentations	5%	nCPE
	Applications	Projects Evaluations	15%	CPE
	State of the art	Presentations	10%	nCPE
Minimum standard of performance				
50% after suming column 4 values				

(*) REP – required for exam participation; nREP – not required for exam participation; RFE – required for final evaluation.

Date of completion: 14. 09. 2019

Date of approval in the Department:……………………………….

	Position, title, first name, surname	Signature
Course instructor	Prof. Lucian VINTAN, PhD	
Head of department	Prof. Eng. Daniel VOLOVICI, PhD	

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